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JOURNAL OF SCIENCE

Official Organ of the

OHIO ACADEMY OF SCIENCE

and of the

OHIO STATE UNIVERSITY SCIENTIFIC SOCIETY

VOLUME XXIII — 1923

OHIO STATE UNIVERSITY
COLUMBUS

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THE OHIO JOURNAL OF SCIENCE

Vol XXIII JANUARY-FEBRUARY, 1923 No 1

EMERSON McMILLIN

BORN, EWINGTON, OHIO, APRIL 16, 1844

DIED, DARLINGTON, MAHWAH, NEW JERSEY,
MAY 31, 1922

Soldier, merchant, contractor manager banker, early an investigator, always a patron of scientific research, member of the Ohio Academy of Science since 1892

In the death of Mr McMillin the Ohio Academy of Science has lost a member whose loyalty has not flagged during a quarter century of absence from the State, and whose scientific sympathy and generous financial support have contributed in a notable degree to the research work of the Academy and its membership

A more adequate memorial will be presented at the next Annual Meeting of the Academy

REPORT OF THIRTY-SECOND ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The Thirty-second Annual Meeting of the Ohio Academy of Science was held at Ohio State University, Columbus, April 14 and 15, 1922, under the Presidency of Professor Raymond C Osburn Eighty-seven members were registered as in attendance, forty-six new members were elected

On invitation of the geologists of the Michigan Academy of Science, a number of the members of the Geological Section of the Ohio Academy, under the Vice-Presidency of Professor Kirtley F Mather, participated in a joint field meeting, held June 3 and 4, for the study of the glacial geology and Silurian rocks of Southeastern Michigan and adjoining portions of Ontario The party was under the leadership of Mr Frank Leverett, of the University of Michigan, and Professor W H Sherzer, of the Michigan State Normal College Professor J E Carman, of Ohio State University, collaborated in directing the investigations at certain localities

GENERAL PROGRAM

FRIDAY, APRIL 14

9 30 A M —Business Meeting
11 00 A M —Reading of Papers in General Session
12 30 P M —Luncheon
2·00 P M —Demonstrations
2 30 P M —Joint session with the Ohio State University Chapter of Sigma Xi, Illustrated Lecture by Professor L R Jones, of the University of Wisconsin, on "Disease and Disease Resistance in Plants"
3 30 P M —Reading of Papers in Sectional Meetings
6 00 P M —Dinner
7.30 P M —Address by the President of the Academy, Professor Raymond C Osburn, Ohio State University, on "Some Common Misconceptions of Evolution"
9:00 P M —Adjourned Business Meeting

SATURDAY, APRIL 15

9·00 A M —Adjourned Business Meeting

10·00 A M —Illustrated Lecture by Professor Dayton C Miller, Case School of Applied Science, on "Ether-Drift Experiments at Mount Wilson California"

11·00 A M —Reading of Papers in General Session

12.30 P M —Luncheon

2 00 P M —Demonstrations

2.30 P M —Reading of Papers in Sectional Meetings

SATURDAY, JUNE 3, and SUNDAY, JUNE 4

Joint Excursion of Section for Geology, with Geologists of Michigan Academy of Science

MINUTES OF BUSINESS MEETINGS

The first business session was called to order by President Osburn at 9 30 A M, on Friday, April 14 Adjourned sessions were held after the presidential address on Friday evening and at 9.00 A M on the following day

The appointment of the following committees for the meeting was announced by the chair

Committee on Membership—A P Weiss, W G Stover, F C Blake

Committee on Resolutions—S I Kornhauser, Stephen R Williams, L G Westgate

Committee on Necrology—G D Hubbard, Herbert Osborn, F L Landacre

The following Auditing Committee was elected by the Academy M E Stickney, F L Landacre

The following Nominating Committee was elected by the ballot of the Academy W M Barrows, W G Stover, G D Hubbard, Alpheus W Smith, F L Landacre, H E Burtt.

Report of the Secretary

The following report by the Secretary was received and ordered filed

April 4, 1922,

To the Ohio Academy of Science

The work of the Secretary for the year has been largely routine, but a few items are of some general interest

A brief report of the Thirty-first Annual Meeting was prepared for *Science*, and appeared in the issue for September 23

The Secretary was present to represent the Academy at the meetings of the Council of the American Association for the Advancement of Science, held in connection with the Toronto meeting

The blank form for nomination of fellows was prepared, as directed, and mailed to all members in connection with the preliminary announcement of this meeting The certificate of election to fellowship is in preparation, a proof was submitted to the Executive Committee for suggestion and criticism at the meeting of April 13

The following letter was received from the Wisconsin Academy of Science, Arts and Letters —

Sept. 15, 1921

The Secretary, Ohio Academy of Science, Columbus, Ohio

My Dear Sir We take great pleasure in sending to your institution, under separate cover the bronze medallion issued in 1920 in commemoration of the fiftieth anniversary of the founding of the Wisconsin Academy, 1870–1920

We ask you to accept it with our fraternal greetings

A brief description of the medallion, with a short statement of its significance, is sent with the medallion itself A fuller account is printed in the Fiftieth Anniversary volume, Volume XX of the Transactions of the Academy

Yours very truly,

Chancey Juday, *Secretary*

The medallion was duly acknowledged, and has been placed with the archives of the Academy in the Library Building

A letter from V A Latham, corresponding secretary of the State Microscopical Society of Illinois, contains the following sentences, asking for the co-operation of members of the Academy

"Is there any one you know of who might have duplicates of Scientific Journals, especially Microscopy? We are anxious to complete ours and the John Crerar Library, and any help through your Academy would be appreciated We had so many former microworkers in your state who were members" Dr Latham may be addressed at 1644 Morse Ave, Rogers Park, Chicago

Several years ago the Secretary suggested the desirability of concentrating the administrative work of the Academy in Columbus by the election of a Columbus man as secretary This suggestion may well be repeated at this time The increase in membership, the organization of new sections, and the affiliation with the American Association for the Advancement of Science have so materially increased the routine work of the secretary and treasurer that the Academy should look forward in the very near future to the organization of a regular Academy headquarters in Columbus, with salaried secretary and treasurer, or, probably better, a secretary-treasurer, for efficiency would be conserved in various ways by the combination of the two offices This matter is further considered in the report of the Executive Committee

Respectfully submitted,

Edward L Rice, *Secretary*

Report of the Treasurer for the Year 1921-1922

The report of the Treasurer was received as follows and referred to the Auditing Committee whose report is appended

Balance in Hayden-Clinton Bank March 17, 1920 as previously reported	$515 74
Received from C W Reeder, Librarian, for 1920-1921 sales of publications	12 95
Received from members for dues to A A A S and the Ohio Academy	1,174 10
Total	$1,702 79
Less checks	1,085 27
Balance in Bank April 12, 1921	$617 52

The Disbursements have been as follows

To E L Rice for Secretarial expenses	$ 37 81
To L H Tiffany for expenses of Business Manager	5 00
To Eunice Evans for assistance for the Treasurer	7 75
To Postmaster, Columbus for letter head envelopes	19 46
To Independent Print Shop	30 75
To Spahr & Glenn	101 00
To B E Livingston for dues for members of the A A A S	633 50
To L H Tiffany for the Ohio Journal of Science	250 00
Total	$1,085 27

Cr

Balance carried forward	$ 515 74
Cash deposited	1,187 05
	$1,702 79

Dr

As itemized expenditures	$1,085 27
Balance in hand	617 52

There has been received from C W Reeder $37 00 for 1921-1922 sale of publications of the Ohio Academy of Science, which is not included in the account as given

Below is the statement of the Manager of Ohio Journal of Science Mr L H Tiffany which your Treasurer desires to have included in this report, feeling that the members of the Academy are entitled to know the present financial status of the Journal

FINANCIAL STATEMENT OF OHIO JOURNAL OF SCIENCE

(Volume XXI 1920-21 The Ohio Journal of Science)

Receipts—		
Balance from J S Hine, 1920-21	$ 19 15	
Separates from Vol XXI	286 91	
Extra copies of "Journal"	9 10	
Subscriptions to Vol XXI	16 00	
Ohio State Univ Annual Allowance	500 00	
Total Receipts		$831 16
Expenditures		
Bucher Engr Co , plates, half tones, etc	$127 50	
Spahr & Glenn, printing	500 00	
Postage and express	60 82	
Envelopes, bill heads, etc	7 90	
Total expenditures		$696 22
Balance on hand, 1920-21		$134 94

Cost of printing "Journal"	$830 25	
Cost of printing separates	252 00	
Total printing cost		$1,082 25
Total cost of printing	$1,082 25	
Paid on account	500 00	
Unpaid		$582 25
Balance on hand		134 94
Deficit for 1920-21		$447 31

The deficit indicated for 1920-1921 for the Ohio Journal of Science has been partially relieved by the payment of $250 This is the amount derived from the dollar of the individual membership fee toward the upkeep of the Journal, as provided for in the Constitution of the Ohio Academy of Science It should be noted that this is the amount derived from membership dues for 1921-1922 and advanced to the Business Manager, in order that he might pay current expenses As more dues are paid, more money will be advanced, but your Treasurer is not empowered to advance more than the amount allowed by the Constitution He feels that definite measures should be provided for permanently relieving the embarrassment of the Ohio Journal of Science, which has been and is well managed and has only fallen into debt because of the rising costs of publication The Journal has a large and growing circulation and is a medium for the communication of papers of the members of the Academy within the State and abroad It offers rather prompt publication, a desideratum well worth considering in these days of over-crowded journals, many of which face a more serious deficit than our own

There are two proposals which the Treasurer desires to offer as a means of removing the deficit of the Journal They are both temporary relief measures The first is that money be advanced from the Research Fund This is the more attractive proposal, because the product of scientific research must sooner or later be communicated to some scientific audience The research fund is open to members of the Academy who desire aid for the completion of their studies It would be of aid to the worker and his audience alike, if the fund should be drawn upon to remove the deficit of the Journal

The second proposal is that the Treasurer be empowered to remove the deficit This has the objection that the measure amounts to the equivalent of increasing, to the subscriber, the cost of the Journal, even though this increase be a temporary one It is to be distinctly understood that the Treasurer is opposed to any permanent increase in the cost of the Journal The Editor, Dr F H Krecker, has the problem of keeping up the standard of the Journal at the least cost, and has not indicated that the price of the Journal to subscribers is too low The two proposals are placed before the Academy with the request that action be taken

In the meantime an active campaign for more funds should be carried on An increase in the number of members is greatly desired An appeal for individual help for the Journal from persons interested in its welfare and for an increased subsidy from the Ohio State University have both been suggested No definite action has been taken on these suggestions as yet

A E WALLER, *Treasurer*

The financial portion of the above report has been examined and found correct

M E STICKNEY,
F L LANDACRE,
Auditing Committee

Report of the Executive Committee

The report of the Executive Committee was received as follows and ordered filed

April 14, 1922

To the Ohio Academy of Science

The Executive Committee has met twice since the last Annual Meeting of the Academy At the first meeting, December 17, Messrs R C Osburn, Waller, Alexander and Rice were present, with Professor Herbert Osborn as guest, at the second meeting, last evening, all members of the Committee were in attendance Several matters of business have also been handled through correspondence

That the date of the Annual Meeting was set for April 14 and 15, in Columbus, is already sufficiently well known

Dean George F Arps was appointed Vice-President for Psychology, to succeed Professor Rudolph Pintner, resigned

Twenty-nine applications for membership have been approved during the year, subject to ratification by the present meeting

A communication was received from Arthur MacDonald, under date of October 11, 1921, urging the adoption of a resolution calling upon Congress to concentrate "the scientific bureaus of the Government under the jurisdiction of the Board of Regents of the Smithsonian Institution, with the view to developing Government science to the highest possible efficiency, by affording scientific workers permanent tenure of office, greater freedom in investigation, non-interference of politics, and adequate salaries " Your Committee deemed it unwise to commit the Academy to this policy

The Committee recommends that the Academy take action urging upon the colleges of Ohio the desirability of a uniform spring vacation, to facilitate for instructors the attendance upon the meetings of the Academy and other professional societies composed wholly or in considerable part of college men

The Committee recommends the amendment of Chapter 1, Section 1, of the By-laws by the addition of the clause "members who have paid regular dues in the Academy for twenty-five years shall also be classed as life members, and shall be relieved of further financial obligations "

The Executive Committee has considered the desirability of modifications of the status of the secretary and treasurer of the Academy in line with the suggestions of the Secretary's report Such readjustments may make desirable the combination of the two offices and the addition to the Executive Committee of a third elective member In order that such action may be possible at the next annual meeting, in case it is deemed desirable, the Committee desires that this report be considered as notification of proposed amendment of the constitution The Committee further recommends the reference of the entire matter to the incoming Executive Committee for further consideration and report

Respectfully submitted,
EDWARD L RICE, *Secretary,*
For the Committee

Report of the Publication Committee

The following report of the Publication Committee was received and ordered filed

The Annual Report of the Thirty first Meeting Proceedings, Vol VII, Part 6, contained 54 pages, including the President's address, which also appeared in the November, 1921, number of the Ohio Journal of Science

It is recommended that beginning with this year the President's address shall be published in the Ohio Journal of Science as soon after the Annual Meeting as possible, that it shall not be offered for publication elsewhere until it has appeared in the Journal and that it shall not be published in the Annual Report

It is further recommended that the Secretary's report shall be published in the Ohio Journal of Science in the summer or autumn, so that the Annual Report can be printed in December

It seems desirable also to publish any special address, delivered on invitation before the Academy in the Ohio Journal of Science

Since the membership of the Academy is increasing rapidly it is the intention of the publication committee to print 750 copies of the Annual Report and of any special papers, instead of 500 as heretofore

Respectfully submitted,
JOHN H SCHAFFNER, *Chairman*

Report of the Library Committee

The following report of the Library Committee was received and ordered filed

April 14, 1922

To the Ohio Academy of Science

The Library Committee begs leave to submit the following report

1 The annual report of the Thirty-first meeting of the Academy, held in 1921, was published in the Ohio Journal of Science for November,

1921, and later reissued with additions as part six of volume seven of the Proceedings of the Academy Copies of this number were mailed to every person on the membership list, and to the seventy-one scientific societies on the exchange list

2 The sale of publications during the year has been above the average, the amount received being $37 00 This sum has been turned over to the treasurer

3 Since the members of the Academy are interested in the development of library resources in the natural sciences, the Committee wishes to take this opportunity to call attention to several very notable additions to the collections of the Ohio State University Library made during the year

(a) Academie des Sciences (Paris) Memoires, 1666-1770

(b) Academie Imperiale des sciences de Saint Petersbourg Memoires et bulletin Complete to date

(c) K Akademie der Wissenschaften (Vienna) Denkschriften philosophisch-historische Klasse, v 1-62, 1850-1918
Sitzungsberichte philosophisch-historische Klasse, v 1-180, 1847-48—1915-16
The Library already owns the Denkschriften and Sitzunberichte of the Mathematisch-naturwissenschaftliche Klasse

(d) Annales des sciences naturelles, zoologie et botanique, 1824-1908 in 316 volumes (This is one of the three complete sets in the United States)

(e) Biologia Centrali—Americana, or, Contributions to the knowledge of the fauna and flora of Mexico and Central America, ed by F D Godman and Osbert Salvin, 63 v 1879-1915

(f) Journal of Botany, British and foreign, v 1-46, 1863-1908

(g) Linnean Society of London, Transactions, 1791-1916, 55 vols

(h) Societe d'anthropologie de Paris, Bulletin, 57 vols 1860-1915

(i) Zoological Society of London Transactions, v 1-20, 1833-1915

Needless to say, all members of the Academy are welcome, not only to the use of these new sets, but also to all the sources in the scientific field which are owned by the University Library

Very respectfully,

C W REEDER,
For the Committee

Report of the Trustees of the Research Fund

The following report of the Trustees of the Research Fund was received and ordered filed The financial portion of the report was referred to the Auditing Committee, whose report is appended

To the Ohio Academy of Science

The Trustees of the Research Fund of the Academy submit the following report for the period from March 1st, 1921, to March 28th, 1922

RECEIPTS		
Cash on hand March 1, 1921, as per last report	$870 90	
Check from Mr McMillin.	250 00	
Interest on Liberty Bonds	25 50	
		$1,146 40
EXPENDITURES		
Paid on grants		
Nov 30, 1921, Paul B Sears	$ 6 20	
Feb 14, 1922, James S Hine	50 00	
		$56 20
ASSETS		
Cash on hand March 28, 1922	$1,090 20	
Liberty Bonds at par	600 00	
		$1 690 20
LIABILITIES		
Grants Paul B Sears	$ 46 36	
L B Walton	100 00	
W H Bucher	25 00	
		$171 36
Excess of cash assets over liabilities		$918 84

Two or three recent applications for grants are under consideration Vouchers and receipts for the verification of this report are submitted herewith

Respectfully,

T C Mendenhall,
Herbert Osborn,
George D Hubbard,
Trustees

Examined and found correct

M E Stickney,
F L Landacre,
Auditing Committee

Report of the Committee on Legislation

The Committee on Legislation reported that no further action had been taken since the last annual meeting, but recommended that the committee be continued with a view to presenting desired legislation to the next General Assembly.

Report of the Committee on State Parks and Conservation

In an oral report of progress, the chairman of the Committee, Professor Herbert Osborn, mentioned the great advance that has been made in the acquisition of protected tracts by the Division of Fish and Game of the State Department of Agriculture and by the State Forester, and emphasized the cordial attitude of these officers toward the permanent preservation of the native fauna and flora of these tracts He also called attention to the very valuable list of Ohio areas desirable for preservation compiled by Dr E Lucy Braun, representing the Ecological Society of America, and urged the co-operation of the Academy membership in the extension of this list by the report of additional interesting localities

Director Taber, of the State Department of Agriculture, was invited by the committee to address the Academy, and spoke very interestingly of the present condition of the tracts owned and leased by the State as game preserves and the plans of the Department for their development and control He expressed a keen interest in the preservation of all forms of native plant and animal life in these tracts and the desire that the Academy assist, through its Committee on State Parks and Conservation and its individual membership, by the suggestion of desirable tracts and control measures

On his own request, Professor M M Metcalf was excused from the committee, and Professor E R Hayhurst elected in his place The committee now consists of Herbert Osborn, chairman, J E Carman, E R Hayhurst, F H Herrick, C G Shatzer, E N Transeau

The following recommendations of the committee were approved by the Academy

1 That the Committee on State Parks and Conservation be made a standing committee, and that the details concerning time of service and future elections be referred to the Executive Committee

2 That the Academy favors the establishment of a State Commission on Parks and Conservation, composed of one representative each for the Division of Fish and Game of the State Department of Agriculture, the Division of Forestry of the Ohio Experiment Station, the State Board of Public Works, the State Archeological Society, the State Geological Survey, and the State Board of Health, and two representatives for the Ohio Academy of Science—one a botanist and one a zoologist

3 That the duties of this commission shall include the following To advise and co-operate in the selection of tracts desirable for state parks, forests, game refuges and scientific reservations, to formulate regulations as to the manner in which such tracts may be used for recreational, historic, refuge, scenic scientific, or other purposes, and to inaugurate measures for the most efficient development of the various tracts for the purposes agreed upon

The Academy further voted to suggest that the committee consider the advisability of employing a salaried officer to promote conservation work in Ohio

Election of Officers

The following officers and committee members for 1922-23 were elected by the ballot of the Academy

President—Professor A P Weiss, Ohio State University, Columbus

Vice-Presidents

- *Zoology*—Professor C G Rogers, Oberlin College, Oberlin
- *Botany*—Dr E Lucy Braun, University of Cincinnati, Cincinnati
- *Geology*—Professor K F Mather, Denison University, Granville
- *Physics*—Professor R C Gowdy, University of Cincinnati, Cincinnati (Professor Gowdy declined the vice-presidency, and Professor Alpheus W Smith, Ohio State University, was appointed by the Executive Committee to fill the vacancy)
- *Medical Sciences*—Professor C F Spohr, Ohio State University, Columbus
- *Psychology*—Dr H H Goddard, Ohio Bureau of Juvenile Research, Columbus

Secretary—Professor E L Rice, Ohio Wesleyan University, Delaware

Treasurer—Dr A E Waller, Ohio State University, Columbus

Elective Members of Executive Committee—Professor R C Osburn, Ohio State University, Columbus, Professor Lynds Jones, Oberlin College Oberlin

Member of Publication Committee—Professor H C Sampson, Ohio State University, Columbus

Trustee of Research Fund—Professor G D Hubbard, Oberlin College, Oberlin

Member of Library Committee—Mr C W Reeder, Ohio State University, Columbus

Representatives on Editorial Board of Ohio Journal of Science

- *Zoology*—Professor R A Budington, Oberlin College, Oberlin
- *Botany*—Professor Bruce Fink, Miami University, Oxford
- *Geology*—Professor G D Hubbard, Oberlin College, Oberlin
- *Physics*—Professor S J M Allen, University of Cincinnati, Cincinnati
- *Medical Sciences*—Professor F C Waite, Western Reserve University, Cleveland
- *Psychology*—Professor H A Aikins, Western Reserve University, Cleveland

Election of Members

The Membership Committee reported seventeen names for election to membership, twenty-nine additional names, previously approved by the Executive Committee and marked with (*) in the following list, were presented for ratification All were elected, as follows

*****ALLEN, WILLIAM RAY**, Zoology, Ecology, Municipal University of Akron, Akron
*****AUTEN, MARY**, Zoology, Entomology, Botany, Botany and Zoology Bldg , Ohio State University, Columbus
*****AXEL, ROBERT**, Psychology, 980 Clinton St , Bronx, New York, N Y
*****BARINGER, JOHN W** , Plant Pathology, Botany, Dept of Botany, Ohio State University, Columbus
BULGER, J W , Entomology, Plant Pathology, Zoology, Dept of Zoology and Entomology, Ohio State University, Columbus
*****CONREY, G W** , Geology, Soils Dept , Ohio State University, Columbus
ELWOOD, P H , Landscape Architecture, Ohio State University, Columbus
*****ESPER, ERWIN A** , Psychology, Ohio State University, Columbus
*****FARNSWORTH, PAUL R** , Psychology, 128 W Tenth Ave , Columbus
*****GORDON, ROBERT B** , Botany, Ornithology, 478 W Seventh Ave , Columbus
GOSSARD, H A , Entomology, Zoology, Wooster
*****HALSTED, FRANCES J** , Psychology, Physiology, 1 Thirteenth Ave , Columbus
*****HARTMAN, GRACE L** , Botany, Physiology, 1868 Rosalind Ave , East Cleveland
*****HATCH, ELIZABETH M** , Psychology, 9 Twelfth Ave , Columbus
HOSKINS, R G , Physiology, 710 N Park St , Columbus
*****HUMPHREY, SYLVESTER S** , Botany, Plant Pathology, Dept of Botany, Ohio State University, Columbus
*****ISRAEL, HAROLD**, Psychology, 22 Fifteenth Ave , Columbus
*****KLECKNER, M E** , Chemistry, Heidelberg University, Tiffin
*****KOCH, BERTHE COUCH**, Psychology, 303 Whittier St , Columbus
LEE, M O , Zoology, Dorset
McCORMICK, ROBERT N , Zoology, 161 W Tenth Ave , Columbus
*****McGLENCHAY, CHLOIE D** , Psychology, 52 Pacemont Road, Columbus
*****MADISON, HAROLD L** , Botany, Zoology, 2289 Grandview Ave , Cleveland Heights
*****MANLEY, R M** , Physics, Chemistry, Structure of Universe, 738 Schofield Bldg , Cleveland
MARQUART, J ROGER, Zoology, Botany, 900 N Limestone St , Springfield
MYER, BERNARD S , Botany, Dept of Botany, Ohio State University, Columbus

Neiswander, Claud R, Zoology, Rawson
*Parrot, G H, Biology, Geology, Physics, 41 E Eighth Ave Columbus
*Peters, Harold S, Ornithology, Botany, 150 W Fourth Ave, Columbus
*Polkowski, Anna, Psychology, 52 Pacemont Road, Columbus
*Pressey, Mrs Luella W, Psychology, Apt 18, Indianola Courts, 1778 N High St, Columbus
*Pressey, Sidney L, Psychology, Psychiatry, Dept of Psychology, Ohio State University, Columbus
Raup, Hugh M, Zoology, Botany, 1845 N Fountain Blvd, Springfield
Runnells, Harmon A, Botany, Botany Dept, Ohio State University, Columbus
Secrest, Edmund, Forestry, Ohio Experiment Station, Wooster
Setterfield Hugh, Zoology, Botany, Myers Hall, Springfield
Sisson, Septimus, Veterinary Medicine, Anatomy, Ohio State University, Columbus
Smith, Alpheus W, Physics, Ohio State University, Columbus
Smith, Alva W, Physics, Ohio State University, Columbus
Smith, Russell M, Chemistry, Botany, 69 Neal Ave Newark
*Spencer, Herbert, Entomology Zoology, Ecology, Botany and Zoology Bldg, Ohio State University, Columbus
*Stauffer, A S, Botany, 220 S Main St, Ada
*Stockdale Paris B, Geology, Dept of Geology, Ohio State University, Columbus
*Van Horn, Frank R, Geology, Case School of Applied Science, Cleveland
*Wembridge, Mrs Eleanor, Psychology, 1681 Fulton Road Cleveland
*Wembridge, Harry, Psychology, 1681 Fulton Road, Cleveland

Report of the Committee on Election of Fellows

The following report of the Committee on Election of Fellows was accepted and ordered filed

April 14 1922

To the Ohio Academy of Science

A meeting of the Committee on Election of Fellows was held on the evening of April 13th Five of the joint committee were present, four were represented by duly authorized proxies, two were absent without representation, although the proxy of one arrived just after the close of the meeting

Sixteen nominations were received by the committee In the consideration of these nominations the committee was guided by the principles laid down last year—that members should not be elected to fellowship until one year, at least, after election to membership, and that resident members should not be elected to fellowship who are not showing an active interest in the work of the Academy

Eleven of the nominees received the necessary nine votes (unanimous for those present at the meeting), and were duly elected to fellowship The newly elected fellows will receive personal notification, and the list will be published in the Annual Report

EDWARD L RICE, *Secretary,*
For the Committee

The list of members elected to fellowship is as follows

ANNETTE F BRAUN
E E CLAYTON
W C DEVEREAUX
HENRY H GODDARD
CLARENCE H KENNEDY
KIRTLEY F MATHER
SUSAN P NICHOLS
BRADLEY M PATTEN
JASPER D SAYRE
ALPHEUS W SMITH
FRANK R VAN HORN

Report of the Committee on Resolutions

The following message and resolutions were presented by the Committee on Resolutions and adopted by the Academy The message was transmitted to Mr McMillin in a night letter, and reached him on his seventy-eighth birthday, April 16, the day after the Academy meeting Mr McMillin's reply follows the telegram

(1) Message to Mr Emerson McMillin, Darlington N J

The Ohio Academy of Science in its thirty-second annual meeting in Columbus desires to extend to you on the occasion of your seventy-eighth birthday its heartiest congratulations, and wishes to express to you its appreciation of your continued support of scientific research through the Academy

REPLY OF MR MCMILLIN

DARLINGTON MAHWAH NEW JERSEY, April 18, 1922

DEAR MR SECRETARY

Your telegram conveying the Birthday Greetings of the Ohio Academy of Science was received on time, and was the best tonic I have received during the last fifteen months of almost continuous illness I do thank you and the Academy most sincerely

EMERSON MCMILLIN

EDWARD L RICE, *Secretary*

(2) The Ohio Academy of Science wishes to express to the Local Committee and to the authorities of Ohio State University its appreciation for the hospitality extended to the Academy on the occasion of its thirty-second annual meeting

(3) The Academy wishes to thank Dr L R Jones for his interesting and instructive address on "Disease and Disease Resistance in Plants" delivered before the Academy

(4) To Dr Dayton C Miller the Academy wishes to express its thanks for his stimulating address on "Ether-Drift Experiments at Mount Wilson, California"

S I KORNHAUSER,
S R WILLIAMS,
For the Committee

Report of the Committee on Necrology

The following report of the Committee on Necrology was adopted by the Academy and ordered filed

BIOGRAPHICAL SKETCH OF GEORGE FREDERICK WRIGHT

By GEORGE D HUBBARD,*
Oberlin, Ohio

In the passing of Professor George Frederick Wright a long life of active, productive work has closed and there goes from our midst one who has been an example and an inspiration to us all Dr Wright was born in Whitehall, New York, January 22nd, 1838 His death occurred on April 20th, 1921, of heart failure following influenza He came of sturdy New England Puritan stock On his mother's side, the family had been on American soil since 1640, on the father's side perhaps equally long Mr Wright's father was a farmer, and this son, one of a large family, acquired his early education in the local schools At the age of seventeen he had gone as far as the district school could take him, and went out to teach a term in the only kind of school he knew

It was in 1855, while still only seventeen, that he made the long journey from the old family home at Whitehall to the little college of Oberlin Four years were spent in the undergraduate course and three in the theological seminary These seven years came at a time in the history of Oberlin as well as of the nation, when the social and even the political order trembled, and great questions were before the people Mr Wright found Oberlin a splendid place in which to feel his way in the discussion and solution of theologic, scientific, social and political questions, and he always took an intelligent part in such activities These seven years not only gave him his college and seminary course, but laid the foundations for his future career They brought out many of the qualities that were subsequently to give him the place he took in the world

His first public service was a ten-year pastorate of the Congregational Church at Bakersfield, near St Albans, in northwestern Vermont His next residence was nearly an equal period at Andover, Massachusetts, as pastor of the Free Church, a residence which threw him in close contact with the stimulating faculty of Andover Theological Seminray The friendships and intercourse of this period proved of very great value in Mr Wright's life work. Not only did he meet the men of the Andover faculty, but he came in close contact with scholars of Boston, New Haven, and New York, to whose influence he readily responded From Andover he was called to Oberlin in 1881 to become professor of New Testament Language and Literature in the theological seminary Eleven years later, through the interest and generosity of a friend who established a chair for the purpose, Prof Wright was made head of the department of The Harmony of Science and Revelation. In 1907 he reached the retiring age and became Emeritus Professor in the same chair until his death Thus he had twenty years of pastoral work, twenty-six years of seminary teaching and fourteen years as Emeritus Professor

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*The author is quite unfamiliar personally with all of Professor Wright's experience save the last fifteen years, but is very happy to have known him so well in these later years Owing to this lack of first hand information, extensive and frequent use has been made of life sketches prepared for other purposes, even to the borrowing of phrases and sentences Credit and thanks are hereby given for all

When Mr Wright began his first pastorate he set apart his mornings for scientific study, and they were as carefully preserved for that work as any student preserves his best hours to prepare for his class work Part of his time was given to field work, a considerable portion to translation from Greek and German, work which greatly increased his proficiency in foreign languages His studies took him through much theological and scientific literature, among which was Darwin's "Origin of Species " He did very little writing for publication until he entered the second pastorate at Andover, but here the papers began to come at frequent intervals A few dealt with glacial problems, many with theologic and philosophic questions, and even here there began the long series of papers which came from his pen expressing his belief that there was nothing in science to hinder one's faith in God, Jesus and miracles Although a strong champion of the theory of evolution, he was also a firm believer in evangelical Christianity He believed in applying pragmatic tests to Christianity as much as to scientific truth, and this, much to the advantage of both His scientific studies confirmed his religious conviction and theological conclusions Open to truth from any source, research or revelation, he believed that no truth could be contradictory, since all was God's, whether expressed in His works or word

While Prof Wright's scientific training was very meagre, his scientific interest was always to the front The home of his first pastorate was on a sand plain with esker and kame connections This was in the days when the glacial theory for the drift had only begun to make its way Mr Wright studied his immediate environment until he became certain that it was the work of a sub-glacial stream His residence at Andover was also on a prominent glacial feature known as Indian Ridge It had been popularly attributed to the work of the Indians, but Mr Wright thought differently and in 1873 in the Bulletin of the Essex Institute he published his first geologic paper It covered only three or four pages, but it interpreted the ridge as wholly of glacial origin and predicted the finding of its continuation for many miles to the north His paper inspired observers, and within a few months he had several invitations to visit localities in line with Indian Ridge These he followed up and established the explanation which he had suggested

These early radical interpretations of the drift and of many of its forms earned the approval of Asa Gray and Clarence King, and this placed Wright's work in the front rank He collaborated later with J P Leslie and with H C Lewis, of the Pennsylvania Geologic Survey and with G H Cook, of the New Jersey Geologic Survey He traced the moraines and ancient ice borders across New Jersey, Pennsylvania, Ohio, Indiana, Illinois, mostly in the eighties, and published in 1890 Bulletin 58 of the U S G S, summarizing his results In later years he studied glaciers and the products of their work in Alaska, Greenland, the British Isles, Holland, Belgium, and France, and journeyed completely across Siberia and Russia in his quest for glacial phenomena These researches gave him the basal material upon which he built the superstructure which made him one of the first men of his age in glaciology

His field studies were not confined to the work of glaciers, for from the earliest to the end, he was intensely interested in the remains of man that he found associated with the drift This material was sought and found in many places where he studied the drift itself Nor did such interest and research stop with man and the drift, for he has been an archeologist in all his travels in Italy, Greece, Palestine, in the region east of the Caspian and in his long journey to Siberia, as well as in the classic fields of western Europe One of his books deals with the ice age in North America, another, the antiquity of man, and a third, man and the glacial period These two lines of research were inseparably connected

While his ministry covered but twenty years and his educational work technically but twenty-six, his research work covered his whole life His educational work began with the district school before he came to college, was continued in several terms of vacation teaching while in college, and was taken up in his own seminary about twenty years after his graduation Many of those who were in his classes or knew him as a teacher speak of his kindness of heart, breadth of scholarship, and above all, his keen interest in the students He was always looking for the best in them, suggesting lines of work for which he thought they were adapted, and was continually rejoicing in the successes of young people whom he knew

The second professorship at Oberlin which was given to Prof Wright in the seminary was established by a friend of the institution who stipulated that the holder should teach but half the year and travel the other half It was this arrangement which opened up to Mr Wright the opportunity of travel in Europe in 1892, Greenland in 1894, and his round-the-world trip in 1900-1901 In this latter trip, covering nearly 30,000 miles, he sailed from the United States west coast and after spending some time in Japan, visited Vladivostok and Manchuria, Peking and Kalgan, and made the long journey by rail across Siberia to Irkutsk From here he journeyed southward and westward through Merv and Samarkand, crossing the Caspian to Tiflis and the Caucasus Mountains, and then proceeded to Constantinople, Palestine, Egypt and southern Europe

On this trip he was royally received in Japan and Russia, and gave a number of lectures in several places In fact, Prof Wright has always had the ability to give an entertaining, inspiring and instructive address No record of his platform performance has been found, but it is well known that he was always sought for public addresses on all kinds of occasions, both in his home town and far away Within a few months of his death he spoke to a learned audience for an hour perfectly logically and without notes He seemed to have the faculty of marshalling in his public addresses a wealth of information, all organized and laid away for any sudden emergency While not eloquent, he spoke with convincing directness and clearness His hearers knew he was thoroughly convinced of what he said He never trifled with an audience, but took them fully into his confidence

As an author and publisher Mr Wright achieved more than many men who do nothing else His published papers number some five hundred and fifty and his volumes sixteen, some of which were translated into foreign languages, and at least one copyrighted in England His "Ice Age in North America" has been through six editions and is considered a standard work in its field Other books have been through more than one edition His "Story of My Life and Work," published in 1916, sums up many of the conclusions in science and theology which he had reached through his years of study and thought It also gives a fairly complete bibliography of his papers, the first of which is entitled "Ground of Confidence in Inductive Reasoning " and appeared in 1871, when he was thirty-three years old But four titles more appear in the next four years, then they come faster, and eight or ten, sometimes fifteen a year flow from his facile pen Not a year passed but saw papers or book reviews added to his voluminous bibliography, and the last paper was prepared during his last sickness, which was on him for some thirty days

Beside the papers and books which he prepared for the press himself, he was editor and really the life and heart of the magazine "Bibliotheca Sacra" for thirty-eight years, beginning in 1883 In the year 1900, he with two or three other men in Washington founded a second magazine, "Records of the Past," which continued for twelve years, and then after the publication of a very complete index, was merged in another magazine

In music, too, he had an active interest A member of the Oberlin Musical Union for almost forty years, he sang in many oratorio concerts He brought back and put into shape for American use a number of Russian songs, and was one of three active editors for a very excellent church hymnal

A cursory glance through the list of his papers reveals the marvelous range of his studies—apologetics, religion, theology and philosophy, politics, history, and biography, commerce geography, travel, and aesthetics, besides his two great fields of glaciology and archeology Some of his papers were conciliatory, some controversial, a few were critical, most of them constructive

Professor Wright was fraternal in spirit and delighted in the fellowship and stimulus of co-workers yet he has never amassed memberships in learned societies His affiliations were as follows

Fellow, American Association for the Advancement of Science
Fellow, Geological Society of America
Boston Society of Natural History
Fellow, Essex Institute
Ohio Archeologic and Historical Society, (Pres , 1908)
Fellow, Ohio Academy of Science, (Pres , 1899)

In later years he has been unable to attend our meetings annually, but his presence was always profitable and stimulating to the Academy

Prof Wright was many-talented, and hence many sided in his interests and pursuits The amount of his work reveals both his unusual capacity for turning it off and his great intellectual ability He had a mind in rare degree persistently active, versatile and productive, and he succeeded in gaining interesting and notable attention to his writings and lectures in these many fields, because he made real contributions at many points and always had an attractive way of stating his conclusions

In his writing and public utterance he vigorously defended his conclusions, not from pride or love of controversy, but because he believed in them and because his conscience would not let him do otherwise Whether in his familiar surroundings or in strange lands far afield, he was alert and resourceful, companionable and appreciative No one can say that Professor Wright slighted or mistreated him or intentionally misjudged him He was quiet, unobtrusive, but genial, winsome, and broad-minded His clear-cut features, gracious dignity, and unfailing courtesy always made him a distinguished figure in whatever group he stood He was sympathetic and straight-forward, simple and direct as a child in all his dealings with his fellow men, so guileless that he often could be imposed upon He was honest and conscientious to the last degree himself and was loathe to believe anyone could be otherwise

He was deeply religious by nature, a believer in reason in religion, and faith in science, and out of this combination came his power to make his greatest contributions to the thought of his generation Buoyant and hopeful, always looking forward, his life was full of happiness and achievement, and ran strong to the end He was the same companion, whether in the privacy of his own home or on a difficult field trip or in a formal public gathering As he will be missed in scientific and theologic circles, so will he be missed at home in the community for which he always thought and worked Such a man could not fail to be an inspiration and a tower of strength to his fellows who were permitted to know him

CHARLES BROOKOVER

By Herbert Osborn and Francis L Landacre

(This sketch was not presented at the meeting, but prepared later for publication in the Proceedings)

In the death of Professor Charles Brookover, which occurred at Louisville, Kentucky, March 17, 1922, the Ohio Academy has lost one of its distinguished members, one who for many years was associated in the scientific and educational work of the state and contributed worthily to the academy

He was born in Adams County, Ohio, March 11, 1870, and obtained his collegiate education at Ohio University, at Athens, obtaining the degree of B Ped and M S from that institution He carried graduate work at Columbia University and University of Chicago, receiving his Ph D degree from the latter institution in 1910 He taught in Colorado College, Buchtel College at Akron, Medical Department of University of Arkansas, and in the University of Louisville, Louisville, Kentucky Especially while at Akron, where he taught from 1901 to 1913, he was active in the scientific work of the state, attended our meetings with great regularity and was particularly active in the entertainment of the Academy at its Akron meeting in 1910 He spent a number of summers at the Lake Laboratory and was one of the most esteemed members of the staff, serving as Acting Director during the summer of 1914 He was a man of high ideals and a most cheerful, helpful disposition, and his death is mourned by a host of intimate friends and scientific associates

His research work was largely upon neurology of the lower vertebrates, and in this field he was a recognized authority His papers, while not numerous, were always thorough and conscientiously worked out Very little if any, of his work will need revision He was cautious about propounding hypothesis and always preferred to accumulate a mass of carefully verified facts and then leave the ultimate interpretation to some one else He was not timid in drawing conclusions, but realized fully that the great need, especially in comparative neurology, is a large body of well established facts from which, finally, safe conclusions may be drawn He was quite willing to contribute less than his colleagues provided that his contributions could be considered safe and as far as possible, final What he might have done if he had been in robust health is uncertain With a serious handicap in health, however, his contributions, especially to comparative neurology, are notable and a matter of pride to his friends and colleagues

Amendment of Constitution

ART VI, SECTION 1 *Annual Meeting* Amended to read The date and place of the annual meeting shall be fixed by the executive committee, subject to such instructions as shall be determined by the Academy at the preceding annual meeting, and shall be announced by circular at least thirty days before the meeting The details of the daily session of each meeting shall be arranged by the program committee and announced in the official program immediately before the meeting

Amendment of By-Laws

CHAPTER VI, SECTION 4 *Annual Report* Amended to read The Annual Report of the Academy, including list of officers, list of members, secretary's report of the annual meeting, and such other matter as the publication committee may determine, shall be printed as a separate issue by the publication committee

CHAPTER VI, SECTION 7 *Publication of President's Address and Other Addresses* New section, to read The President's address shall be published in the Ohio Journal of Science as soon as possible after the annual meeting, and shall not be published in another scientific magazine until it has appeared in the Journal Other addresses delivered before the Academy on invitation may be published in the Ohio Journal of Science

Support of Ohio Journal of Science

A detailed statement of the financial status of the OHIO JOURNAL OF SCIENCE is included in the report of the treasurer The question of an additional temporary subsidy to the JOURNAL on the part of the Academy, to relieve the present deficiency, was referred to the executive committee with power

Scientific Sessions

The complete scientific program of the meeting follows

PRESIDENTIAL ADDRESS

Some common misconceptions of evolution — Raymond C Osburn

PUBLIC LECTURES

Disease and disease resistance in plants — L R Jones
Ether-drift experiments at Mount Wilson, California — Dayton C Miller

PAPERS

1 Some proposed state parks for Ohio (15 min) J Ernest Carman
2 Segregation and man (15 min) Maynard M Metcalf
3 American biological stains for microscopical preparations (10 min), S I Kornhauser
4 Further studies in the cytology of Anisolabis (10 min) (Lantern), S I Kornhauser
5 Notes on tropical photography (5 min) William Ray Allen
6 Some unsolved problems in tidal zone ecology (By title) Z P Metcalf
7 Preliminary survey of certain aquatic habitats on the Bass Islands (20 min) (Lantern) F H Krecker
8 Some results from a pure line isolation culture of Euglena gracilis Klebs (5 min) W J Kostir
9 A source of material for study of parasites (5 min) Maynard M Metcalf
10 Specific names for parasites (5 min) Maynard M Metcalf
11 Studies of the biology of freshwater mussels (15 min) William Ray Allen
12 The relationship of the Syngnathidae (15 min) James E Kindred
13 A quarter century of bird migration at Oberlin (30 min) Lynds Jones
14 A case of unhindered growth of the incisor teeth of the woodchuck (10 min) (Lantern) Stephen R Williams
15 A cicindelid from Lake Bennett, British Columbia (10 min) Lynds Jones
16 Factors influencing reproduction in the cucumber beetle (Diabrotica vittata Fabr) (10 min) W V Balduf
17 Distribution and control of two important grape insects (10 min) (Lantern) D M, DeLong
18 A study of the distribution of the leafhoppers of Presque Isle, Pa (5 min) (Lantern) D M DeLong
19 Emergence of a subimago Mayfly (5 min) F H Krecker
20 Some factors which have limited and directed insect evolution (20 min), Clarence H Kennedy
21 Insect parasites and predators in spider s nests (5 min) Mary Auten
22 The inter relation of the Hessian fly (Phytophaga destructor) and one of its parasites (5 min) T H Parks
23 Biological significance of the endocrines (20 min) A B Plowman
24 The effect of formaldehyde on the vitamins of milk (5 min), A M Bleile and R J Seymour
25 Variation in the dandelion and some of its causes (15 min) P B Sears
26 A forest map of the Erie basin (15 min) P B Sears
27 The distribution of flowering plants on the smaller islands of Lake Erie (10 min) Malcolm E Stickney
28 The sexual nature of vegetative or dichotomous twins of Arisaema (15 min) John H Schaffner
29 Influence of length of daylight on sex reversal in hemp (15 min), John H Schaffner
30 Some root and stem rots of clover in Ohio (10 min.) Sylvester S Humphrey
31 Mosaic disease of tomato (10 min) (Lantern) Raymond A Dobbins
32 Energy relations of plants (15 min) E N Transeau
33 Ecological distribution of grasses of North America (15 min.) E L Stover
34 The algal food of fishes (15 min) L H Tiffany
35. Seedling blights of corn (15 min) Wilmer G Stover
36 The course of a plant disease (15 min) Wilmer G Stover
37 Extension work in plant pathology with special reference to the control of corn and potato diseases (20 min.) E E Clayton

38 Barberry eradication in Ohio (15 min) J W Baringer
39 A study of variation in Russula (5 min) H C Beardslee
40 Geologic control of river navigation in northeastern Bolivia (10 min.) (Lantern) Kirtley F Mather
41 The gorges of the Yangtze Kiang (20 min) (Lantern) George D Hubbard
42 An inter-glacial gorge at Youngstown, Ohio (12 min.) G F Lamb
43 New points in the geology of Kelleys Island (10 min.) Mildred Fisher
44 Some new data concerning the Bellefontaine outlier (10 min), Clarence F Moses
45 The Pottsville formation of Ohio (15 min) Helen Morningstar
46 The Bainbridge caves (10 min) Robert F Webb
47 The formation of box canyons in sandstone (20 min.) (Lantern) J E Hyde
48. Mineralization along the dikes of southern Vermont (15 min), Harriet G Bray and Alden E Emery
49 The Wheeler National Monument (15 min) (Lantern) Robert F Webb
50 Colloids in geologic problems (20 min) George D Hubbard
51 Dynamics of the lithosphere (25 min) O C Jones and George D Hubbard
52 Drainage changes north of Lake Superior (15 min) (Lantern), Robert F Webb
53 The Arctic as one of the centers of distribution of early Paleozoic faunas, August Foerste
54 Meanders of Rio Securé and Rio Mamoré, Bolivia (10 min) (Lantern), Kirtley F Mather
55 Iron molding sands of Ohio (15 min.) J A Bownocker
56 Report on the Edward Orton Memorial Library (5 min) J A Bownocker
57 New fish remains from northwestern Ohio (15 min.) J Ernest Carman
58 Some fossils from the Sylvania sandstone (10 min) J Ernest Carman
59 Type specimens of fossils in the geological museum at Ohio State University (5 min) Helen Morningstar
60 Stylolites their nature and origin (15 min) Paris B Stockdale
61 A mounted topographic map of Ohio (5 min) G W Conrey
62 Notes on the Cincinnatian W H Shideler
63 Forecasting the weather in the Ohio Valley (20 min) William C Devereaux
64 The electron theory of metals (15 min) Alpheus W Smith
65 The effect of a unidirectional field upon alternating current permeability and energy loss in iron (15 min) Alva W Smith
66 Infra red absorption bands as a means of determining molecular properties (15 min) Erwin F Lowry
67 Certain aspects of the problem of the static versus the dynamic atom (15 min) F C Blake
68 The study of "illumination" in physics courses (15 min) F C Caldwell
69 Some interesting pictures in infra-red Yale Roots
70 Duriron—a product of Ohio industry (35 min) (Lantern) James Withrow
71 A case of dual personality (20 min) Henry H Goddard
72 The field of psychology (15 min) B H Bode
73 The theory of differential education as applied to the handicapped pupils in the elementray grades (15 min) J E W Wallin
74 Qualitative clinical tests and psychological theory (15 min) H B English
75 Psychic complexes (15 min) A W Trettien
76 A comparison of initial and subsequent examinations of the same individual by the same psychological methods (15 min) Mabel R Fernald

DEMONSTRATIONS

1 (a) Common mole (Scalopus aquaticus machrinus Refinesque) "embalmed" (b) Internal parasites of same F A Hanawalt
2 Tracheation of Lestes nymph Clarence H Kennedy
3 A plerocercoid (larval) tapeworm from the liver of the squirrel—externally segmented Stephen R Williams
4 The head of the woodchuck described in Paper 14 Stephen R Williams
5 Types of tomato mosaic Raymond A Dobbins
6 Seedling blights of corn Wilmer G Stover
7 Stalactites in glacial sand and recent conglomerates from Canton, Ohio, G F Lamb
8. Illumination charts F C Caldwell

IRON MOLDING SANDS IN OHIO

J A BOWNOCKER

State Geologist

There are two classes of molding sands—those for steel castings and those for iron castings The essential difference between them is the melting point Thus steel molding sand must have a fusion point of not less than 1,600° C , whereas that for iron castings need not have a melting point of more than 1,300° C As silica or quartz is the main constituent of all molding sands and is also the chief fusion resisting ingredient, it follows that sand for steel castings must be higher in silica than those for iron castings[*] Analyses of steel molding sands from Ohio show a silica range of from 95 66 to 99 43 per cent, whereas the silica content of iron molding sands from this State varies from 77 65 to 83 49 per cent

DISTRIBUTION OF IRON MOLDING SANDS IN OHIO

Iron molding sands in Ohio are widely scattered, but at present there are three important centers and three of secondary interest The first includes the shore of Lake Erie, Muskingum County, and Perry County Those of secondary interest occur in Gallia, Hamilton, and Butler counties

MOLDING SANDS ALONG THE LAKE SHORE

Molding sands along the south shore of Lake Erie are of the mantle rock variety In other words, they are disintegrated and not obtained by crushing sandstones They are widely scattered, small in area, less than 10 feet in thickness, and lie on low knolls Within the past few years such sands have been worked in Erie and Ashtabula counties

The deposits which are described in the following paragraphs are representative for the area They do not, however, include all that have been worked within the past few years, nor does it follow that all of those described herein are being exploited at the present time

Erie County—The molding sand industry in Erie County began as early at least as 1868 and it is still the most important source along the lake shore. The deposits, which are scattered over all the county except the northwest part, are by far the most important in the eastern half The northernmost deposit worked is on the Shenk farm, about one-half mile south of the Soldiers' Home, where it lies on a low ridge about 200 feet wide, and is probably an old lake beach About 12 inches of soil is removed and 30 inches of molding sand secured The sand has a buff color, is without stratification, and no pebbles were observed Incipient fusion occurs at 1,300° C and complete fusion at 1,424° C Its specific gravity is 2 64

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[*] For discussion of steel molding sands of Ohio see this journal, June, 1921

On the J C Russell farm, south of Avery, is a deposit of molding sand 6 feet thick at the maximum and located on a low knoll It is covered by about 8 inches of soil and has been worked for nearly 20 years The sand has a buff color and is without stratification The surrounding country is slightly hummocky and doubtless carries sand on the knolls, but the area must be small

At Parkertown, on the Pennsylvania Railroad, about 8 miles south of Sandusky, approximately 8 feet of molding sand is worked This differs from most other deposits in the county by the presence of pockets of coarse light-gray sand The molding sand reaches incipient fusion at 1,327° C and complete fusion at 1,436° C Its specific gravity is 2 66

On the H J Mason farm, 2½ miles south of Milan, a maximum of 3½ feet of molding sand is secured from a low knoll, which has a width of perhaps 100 yards The sand has a yellow color and in places is mottled No stratification was observed, but its texture is said to vary within short distances The material is loaded on wagons with a ditching machine. Incipient fusion occurs at 1,300° C and complete fusion at 1,400° C Its specific gravity is 2 67 A large quantity of molding sand is available on this and adjacent farms

Molding sand has been obtained in the vicinity of Ceylon for more than 15 years The material, which lies on low knolls and has a maximum thickness of 6 feet, is without stratification, but contains occasional pockets of clay

Sand from Erie County is used for small or medium-sized castings, such as sewing machines, automobiles, agricultural implements, and marine engines. Much of the material is used in its natural condition, but some is mixed with other sand

When the strength of the sand needs to be increased, molasses or some other binder is added The market extends as far west as Detroit and Chicago, east to Cleveland, and south to Columbus and Hamilton

Sands from this county are very much alike in their physical and chemical properties (see analysis on this page), and in their distribution As previously stated, they lie on low knolls or ridges and are always thin, the heaviest deposit not exceeding 8 feet Further, they are unstratified Of their origin there seems to be no doubt They are deposits that were laid down on the bed of glacial Lake Erie and were later worked over by the wind and deposited by that agent where now found

Interesting to report, when the molding sand is removed, the underlying material forms a good soil and is used for the same crops as was the material which overlay it

Composition of Molding Sands, South Shore of Lake Erie

	Silica SiO_2	Alumina, Al_2O_3	Iron oxide, Fe_2O_3	Titanium oxide TiO_2	Calcium oxide CaO	Magnesium oxide MgO	Ignition loss
Mason farm, 2½ miles south of Milan, Erie County	70 38	7 96	4 75	43	1 22	1 09	2 03
Mason farm, 2½ miles south of Milan Erie County	77 65	9 17	4 34	33	1 14	1 13	2 72
Shenk farm, Soldiers Home, Erie County	83 49	8 86	2 11	33	1 78	1 12	1 32
Russell farm, Parkertown, Erie County	82 20	9 24	3 60	33	1 76	1 13	1 50
Gordon farm, Conneaut, Ashtabula County	79 32	10 08	5 36	70	1 06	1 21	2 48

Ashtabula County —Molding sand in this county is confined to the northeast corner, extending west beyond Kingsville and east to the State line and in fact to Springfield, Pa Nearly all of the deposits lie north of the main ridge road, and hence are near the lake They are patchy and rather small, measured by acres rather than square miles, and lie on low knolls A description of the more important deposits follows

On a knoll on the Hayler farm, northwest of Conneaut and about one-fourth mile from the lake, a deposit 3 feet thick occurs It is covered with 8 inches of soil, which is removed by hand labor The sand has a light yellow color, is unstratified and without pebbles It is hauled in wagons, loaded directly on cars, and shipped to Erie, Pa

About 3 miles west of Conneaut on the Gordon farm, a relatively large deposit of molding sand is being worked Beneath 8 inches of soil lies a maximum of 7 feet of sand which varies somewhat in quality The upper part is lighter in color and the lower part slightly mottled, and appears more clayey In places there are thin layers of sand without enough clay to form the necessary bond About one-fourth mile distant is another deposit which has a maximum thickness of 8 feet.

These deposits are transported by a small locomotive to the New York Central tracks, where the sand is milled and shipped Milling, however, consists simply of mixing the sands in varying proportions and in this way four grades are secured The sand from this pit is incipiently fused at 1,336° C and completely fused at 1,436° C It has a specific gravity of 2 68

The product has a wide market, as it is shipped to such distant places as Detroit, Chicago, St Louis, Buffalo, Pittsburgh, and New York

In its physical and chemical properties, its mode of occurrence, use, and origin, this sand is similar to that in Erie County

Physical Tests —Physical tests of molding sand include the transverse and crushing strength, the venting power or permeability to air, the fusion point and the sieve tests The fusion point has already been given and the sieve tests may be found on page 29 Tests for transverse and crushing strength and venting power were made after the methods of the American Foundrymen's Association * For transverse strength, blocks of sand one inch square in cross section and four inches between supports were used, whereas for crushing strength the blocks had the same cross section, but the height was 2½ inches. In each case the breaking weight is expressed in pounds The venting power is the time in minutes necessary to force one gallon of air with a certain pressure through a block of sand one inch thick

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*American Foundrymen's Assoc , Vol 21, p 86

STRENGTH OF LAKE SHORE SANDS IN POUNDS

	Dry	With 5% Water	With 7½% Water	With 10% Water
Transverse strength				
Shenk farm, near Soldiers Home	33	12	09	05
Russell farm, near Parkertown, Erie County	1 10	01	02	00
Mason farm, south of Milan, Erie County	50	21	04	06
Mason farm, south of Milan, Erie County	2 00	32	35	15
Gordon farm, near Conneaut, Ashtabula County	38	10	05	01
Crushing strength				
Shenk farm, near Soldiers Home	8 05	2 08	76	82
Russell farm, near Parkertown, Erie County	8 00	80	77	74
Mason farm, south of Milan, Erie County	10 14	3 71	20	1 81
Mason farm, south of Milan, Erie County	20 00	5 32	5 76	2 80
Gordon farm, near Conneaut, Ashtabula County	2 91	2 76	77	69

VENTING POWER OR PERMEABILITY TO AIR OF LAKE SHORE SANDS

	Dry	With 5% Water	With 7½% Water	With 10% Water
Shenk farm, near Soldiers Home	42	67	72	48
Russell farm, near Parkertown, Erie County	17	45	30	43
Mason farm, south of Milan, Erie County	50	95	1 92	55
Mason farm, south of Milan, Erie County	50	1 05	1 25	50
Gordon farm, near Conneaut, Ashtabula County	42	53	47	58

MOLDING SANDS IN MUSKINGUM COUNTY *

Muskingum County is the most important source of iron molding sands in Ohio and one of the largest sources in the United States Although the principal deposits are in the vicinity of Zanesville, they extend north to Dresden, east to Sonora, and southeast to Duncan Falls In altitude the sands present marked variations—from 700 feet above sea level on the flood plain of the Muskingum River to 900 feet on top of the adjacent hills

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*For a detailed account of the molding sands of Muskingum County see Geol Surv of Ohio, Bull 21, Chap 7

The largest known deposit of molding sand in the county lies on the northern half of South Zanesville hill at an elevation of 900 feet No complete section of these deposits was seen but an employee who has worked on the hill for 15 or more years gave the following succession

Soil	2 ft
Brown sand No 3 No pebbles	8
Brown sand No 1 Finer than the above	4
Coarse gray sand, with many sandstone fragments, but no foreign pebbles	15
Coarse, sharp sand without sandstone fragments	8
Shale, reported	

All this material, except soil at top and shale at base, has been used for molding purposes The two sands below the soil are similar except for fineness of grain and this doubtless varies horizontally Surfaces exposed to weathering show stratification, but fresh surfaces do not These sands are marketed without milling, by mixing them various grades may be secured Both sands are considered a wind deposit, which is indicated by fineness of grain, absence of pebbles or coarse fragments of rock, lack of foreign material, and by their altitude of 900 feet, or 200 feet above the valley

The coarse gray sand which occurs next in descending order contains fragments of shaly sandstone with a maximum length of 4 or 5 inches and a thickness that rarely attains one-half inch They are not evenly distributed, but in places occur in pockets and there may form the larger part of the mass The fragments very closely resemble the coarse shaly sandstone that is found in the surrounding country, from which it doubtless originated This material, sand and shaly sandstone, is hauled to the mill where it is crushed, screened; and then marketed as No 3 sand It is the only hilltop deposit of this type that has been found in the county, moreover its area is small, about 600 feet north-south and 200 feet east-west Doubtless it was the work of running water before the present topography was developed, and its source was the sandy shale or thin-bedded sandstone of the surrounding country

Microscopic examination of this variety was made by Prof W J McCaughey, who listed the following minerals in order of their abundance

1 Quartz
2 Orthoclase
3 Microcline
4 Muscovite
5 Biotite
6 Magnetite
7 Calcite
8 Hornblende
9 Tourmaline
10 Garnet

Chemical analysis of this sand gave Prof D J Demorest the following results

Silica, SiO_2	80 00 per cent
Alumina, Al_2O_3	6 56
Ferric oxide Fe_2O_3	5 34
Titanic oxide, TiO_2	60
Lime, CaO	1 00
Moisture at 105° C	1 27
Ignition loss	2 53

At the east end of the South Zanesville hill is a pit where the following section was measured

Soil	1 ft
Fine sand unstratified, mottled no pebbles	11
Shaley sandstone, rotten	3
Sandstone, rotten	1

The whole section, soil excepted, is worked The rotten shale and sandstone are distinctly stratified and are without doubt in place, that is, have not been transported from some other location

Molding sand has been obtained at several other places on the west side of the Muskingum River Among these may be mentioned the flood plain of this river just below the tube works, at an altitude of 700 feet, top of Putnam Hill at an elevation of 900 feet, near Drake Station, where the sand lies about 820 feet above sea level, is stratified, contains small pebbles, and is therefore considered a water deposit This material is crushed in a dry pan and then screened About one mile north of Ellis the sand occurs at an elevation of 850 feet, is without stratification, and free from pebbles It is fine grained and may be classed as No 1 Near Dresden are two or three deposits which have been worked in recent years The material varies in texture from coarse to fine and in places shows stratification An occasional pebble or rock fragment was found and the sand is therefore considered a water deposit A sample from the pit of the Central Ohio Sand and Gravel Co , one-half mile south of Dresden, was analyzed by Prof Demorest, with the following results

Silica, SiO_2	83 25 per cent
Alumina, Al_2O_3	8 11
Ferric oxide, Fe_2O_3	3 14
Titanic oxide, TiO_2	30
Lime, CaO	.40
Magnesia, MgO	54
Ignition loss	4 28

MOLDING SANDS EAST OF THE MUSKINGUM RIVER

One of the largest deposits of molding sand in Muskingum County lies at an altitude of 900 feet on a hill in the northeastern part of Zanesville The following section was measured in this pit in 1917

	Soil and clay	2½ ft
4	Fine sand	4
3	Red sand	4
2	Coarse sand	2
1	Fine sand	10
	Clay unmeasured	

The basal sand is marketed as No 0 and No 1, it is used for brass and for small iron castings Sand 2 of the section is not commonly used alone, but is mixed with 3 and 4 and then makes No 2 and 3 sands Sand 3 was not marketed alone when the pit was visited, but was mixed with other sands Sand 4 was mixed with 2 to form a No 2 sand

The silica range of sands from this pit, according to Prof Demorest, is from 81 76 per cent to 85 99, alumina from 5 24 to 8 26, and iron oxide from 2 94 to 4 20

Sands similar to those just described have been worked directly across the river from the American Rolling Mill Co at an altitude of 800 feet

Near the eastern limit of Zanesville are numerous deposits of molding sand One of these, opened about 35 years ago, measures approximately 30 feet in thickness It consists of sand and clay, the latter measuring as much as 10 feet in depth The sand is distinctly stratified and carries many pebbles, some of which measure 4 inches in diameter The sand and clay are ground together and then screened By mixing the materials in varying proportion several varieties of sand are secured

At the station Oakland is another deposit and, like the preceding one, it lies about 820 feet above sea level When visited it had a maximum thickness of 15 feet, contained many small pebbles, and was distinctly stratified Near-by is a ledge of about 12 feet of coarse sandstone, which is ground with the sand On top of the knoll is a thin bed of brown sand, without pebbles or stratification By mixing these deposits, as many as 14 varieties of molding sand are reported to have been produced

Molding sands exist southeast of Zanesville and have been worked near Lawton and Pierce A smaller deposit occurs a mile north of Duncan Falls

MOLDING SANDS IN PERRY COUNTY

The one important center for molding sand in Perry County is in the valley of Rush Creek and the deposits now worked extend from about 1 mile to perhaps 3 miles east of New Lexington

The materials which form the basis of the industry are sandy loam and rotten sandstone The sandy loam was formed by the disintegration of sandstone or sandy shale and it gradates into the underlying rotten sandstone Above the loam is 1 to 2 feet of soil, which is rejected These materials lie above the No 6 or Middle Kittanning coal, and hence near the top of the Allegheny formation

The plant of the New Lexington Sand Co , which lies about one mile east of New Lexington, was opened in 1904 and is the pioneer plant of the district Following is a section in the pit

Soil	1 ft
Sandy loam (binder)	5
Rotten sandstone	12

The rotten sandstone, which is coarse grained, thin bedded, and carries numerous flakes of white mica, contains some iron, and has a yellow color The company owns 100 acres of good rock, so that its supply of raw material is very large

The materials from this pit are run through a disintegrator and thus reduced to coarse sand, when it is ready for shipment Two grades are made by mixing the rotten sandstone and binder in different proportions In one there are approximately two parts of sandstone to one of binder, whereas in the finer variety these proportions are reversed This sand softened at 1,345° C and liquified at 1,436° C Its specific gravity is 2 64

An analysis of the finer sand (one part sandstone to two parts of binder) from this plant was made by Prof D J Demorest with the following result

Silica, SiO_2	82 17 per cent
Alumina, Al_2O_3.	8 77
Iron oxide, Fe_2O_3	4 44
Titanium oxide, TiO_2	55
Calcium oxide, CaO	50
Magnesium oxide, MgO	79
Ignition loss	3 07

Prof Wm J McCaughey made a microscopic examination of this sand and reported the following minerals which are listed in order of their abundance

1 Quartz
2 Orthoclase
3 Microcline
4 Muscovite
5 Biotite
6 Tourmaline
7 Zircon
8. Magnetite

Quartz and feldspars are the essential minerals, but hornblende and biotite are important accessories Other minerals are found only in small proportions

Just east of the New Lexington sand plant is that of the Superior Sand Co, which works about 20 feet of rock, the upper 3 feet more or less being a sandy loam used as binder and the lower 17 feet a coarse-grained rotten sandstone The material is loaded on cars by a planer which does the work of 10 men The base of the pit is about 20 feet above the Middle Kittanning or No 6 coal

Approximately one-half mile farther east is the plant of the Lancaster Coal and Sand Co, which works about 18 feet of rotten sandstone covered with 3 feet more or less of loam and soil The deposit lies about 20 feet above the Middle Kittanning or No 6 coal It is worked with a steam shovel and run through a disintegrator Shipments were first made in 1919

On the north side of the valley is the plant of the Ayers Mineral Co, which works the rock to a maximum depth of 26 feet, but it is so variable in texture that in places only a few feet is satisfactory The rock is cut and loaded by a planer and is then run through a disintegrator and shipped

The plant of the Jones Sand Co, also on the north side of the valley, at Goston, is the easternmost in the field A section taken in the pit follows

Soil	8 inches
Sandy loam (binder)	4-5 feet
Rotten sandstone	8-9 feet

This plant is unique in that bond and sand are mined separately, whereas the usual practice is to mine them together so that the proportion of sand and bond is not controlled except in a very crude way By separate mining the two constituents may be mixed in any desired proportion Thus one large customer calls for 10 parts of sand to 1 of bond, while another asks for the proportion of 5 to 4

The materials are loaded on cars with a steam shovel and then hauled to a mill where they are run through a disintegrator This sand softened at 1,345° C and liquified at 1,478° C Its specific gravity was 2 64

A sample of No 5 sand from this plant was analyzed by Prof D J Demorest with the following result

Silica, SiO_2	82 06 per cent
Alumina, Al_2O_3	8 01
Iron oxide, Fe_2O_3	3 70
Titanium oxide, TiO_2	35
Calcium oxide, CaO	50
Magnesium oxide MgO	96
Ignition loss	2 72

The same grade of sand was examined microscopically by Prof Wm J McCaughey, who reports the following minerals which are listed in the order of their abundance

1 Quartz
2 Orthoclase
3 Muscovite
4 Microcline
5 Biotite
6 Magnetite
7 Hornblende
8 Albite
9 Epidote

Quartz and orthoclase comprise the mass of the sand Muscovite is common, but most of the other minerals listed are found only occasionally

STRENGTH OF PERRY COUNTY MOLDING SANDS IN POUNDS

	Dry	With 5% Water	With 7½% Water	With 10% Water
Transverse Strength				
No 5 Sand, New Lexington Sand Co	3 88	48	73	39
No 5 Sand, Jones Sand Co , Goston	4 85	62	52	12
Crushing Strength				
No 5 Sand, New Lexington Sand Co	46 65	10 37	10 60	8 21
No 5 Sand, Jones Sand Co , Goston	51 00	8 66	7 72	3 36

VENTING POWER OR PERMEABILITY

No 5 Sand, New Lexington Sand Co	2 30	2 42	2 05	1 67
No 5 Sand, Jones Sand Co , Goston	50	95	55	37

MOLDING SANDS IN GALLIA COUNTY

Molding sands are being developed along the Hocking Valley Railway in Gallia County from Mills Station to the vicinity of Bidwell, a distance of about 6 miles

When visited in September, 1921, the southernmost sand pit was on the Humphrey farm in the northern part of Section 12, Green Township The deposit is lens shaped with a maximum thickness of 14 feet and is covered with approximately 18 inches of stripping Its altitude is 660 feet above tide

The sand has a light brown color It appears very largely unstratified, especially in the upper part, but near the base distinct layers were observed in one or two places Stratified sand was reported below the base of the pit and with a thickness of 4 feet, but it is not mined as it is unsuitable for molding purposes It is said to have various colors, some of it light gray In texture the sand is finest in its higher parts and distinctly coarser below Black streaks were noted in places and sandy concretions were found, but these appeared to be of secondary origin Pebbles were neither seen nor reported The sand is hauled in trucks to the Hocking Valley Railway, 1½ miles distant, and shipped without milling to Michigan, Indiana, and Illinois, as well as various places in Ohio It is used for small castings and especially in automobile work

The largest sand pit in Gallia County is at Kerr, on the Hocking Valley Railway The pit is about 660 feet above sea level, and 6 acres are estimated to have been worked over The deposit is lens shaped and it has a maximum thickness of 16 feet

The color is the usual shade of brown and is similar to that on the Humphrey farm and elsewhere in Gallia County The material is finest in texture near the top, below it is distinctly sandy in places When a fresh surface is exposed there is little or no evidence of stratification, but on weathering layers become distinct Numerous sandstone pebbles were noted, but they can be crushed easily between the fingers and hence probably are of secondary origin

The sand is loaded on cars with a steam shovel and hauled by gravity to a mill where it is run through a disintegrator It is then marketed at Detroit, Chicago, and Indianapolis, as well as in numerous Ohio cities The sand is classed as No 4 and is reported to be one grade coarser than that from the Humphrey farm It is too coarse for fine castings and is used for automobile cylinders, blocks, car wheels, machine frames, etc When working to capacity the plant is reported to produce 250 tons of sand per day

Origin of Gallia County Moulding Sands

Mr J M Weed, County Surveyor, has plotted on topographic maps the locations of all the molding sand deposits that have been worked in Gallia County and they lie pretty uniformly 660 feet above sea level A second characteristic is their stratification, though this is not evident in most places unless the bluff has been exposed to weathering A third factor is the similarity in color, texture, and other physical properties of the several deposits A fourth point is their location in a preglacial valley whose waters flowed north and hence were dammed or ponded by the great continental ice sheet

From this evidence it appears that the sands under consideration are of glacial origin, that they were carried from the ice by glacial streams and deposited in the broad valleys which were at that time occupied by long, narrow lakes When the ice withdrew, the waters of the lakes had found an outlet to the south and the lakes were slowly emptied Probably at that time these silts covered the valley floor, but most of them were removed by subsequent erosion

CINCINNATI AND VICINITY

Molding sand has been shipped from Delhi at the extreme western edge of Cincinnati since about the year 1889 Some of the deposits lie at or near the foot of the river front hills, others on the slopes, and others still on the summits of these hills at an elevation of 800 feet The deposits are small and patchy, and are reported to be restricted to the river front hills between Muddy Creek and Goose Creek

The deposits are of two distinct types—one is fine and loam-like and the other contains pebbles All deposits are lens shaped and the areas are small

The fine loam-like material has a maximum thickness of about 7 feet It lacks stratification, has a yellow color when dry and a tendency to stand with steep slopes In places vertical cracks were noted and these gave the mass the appearance of blocks standing on end This material is used for fine castings and is marketed as No 1, No 2 and No 3 sands In a pit on the land of Jacob Fliehman in the Ohio Valley, the No 1 sand lay at the base and the No 3 sand at the top, with the No 2 between The different grades, however, are much alike in texture as well as in other respects The sand is not milled

The coarse pebbly material was noted only on the tops of the river front hills. It has a yellow color when dry, but a darker shade than that of the fine material at the surface. The pebbles are numerous but small, the largest seen not exceeding 3 inches in diameter. Many of them are well rounded and all appeared weathered. The pebbles are of the common types—igneous, sedimentary, and metamorphic. On exposure faint stratification was observed in one place, but this was not where the pebbles were most abundant. The maximum thickness observed of this pebbly material is about 18 feet. It is used at Cincinnati and other places for large castings. A section on top of a hill on land of Jacob W. Fliehman follows:

Fine sand, No. 1	5 ft.
Light-gray sandy clay, rejected	1
Pebbly sand, No. 4	12
More pebbly sand, No. 5	5

The light gray material between the pebbly sand and the fine material at the top is unsuitable for molding purposes and has to be rejected. It forms a thin layer, not more than one foot in thickness and appears to be persistent. It resembles the "white clays" of southwest Ohio and may be their counterpart.

The origin of these molding sands appears to be clear enough. The fine material has been transported and deposited by the wind, while the pebbly material is of glacial origin. The latter is much the older and was laid down during Illinoian glacial time, long before the glacial deposits in central and northern Ohio. After the pebbly material was deposited the white clays were laid down on them and still later they in turn were buried beneath the fine yellow sands.

About one mile up the Ohio Valley from North Bend and on top of a river-front hill at an altitude of about 740 feet is a deposit of molding sand that has been worked in an irregular way for more than 28 years. The material closely resembles the pebbly variety found at Delhi, but the proportion of pebbles varies greatly and in places they are rare. Occasional pockets of stratified sand were observed in the pebbly material. The maximum thickness of the deposit that has been worked is reported to be 20 feet. The origin of the deposit is similar to that of the pebbly material at Delhi. The pipe works at Addyston, about one mile distant, has been the principal market for this molding sand.

A third source of molding sand in the Cincinnati district is at the village of Cleves, about one mile north of North Bend The deposit is at an altitude of about 640 feet and hence does not lie at the summit of the upland, which here is about 800 feet above sea level

The sand exposed in the pits has a maximum thickness of perhaps 30 feet The top 6 to 8 feet is a loam and below this is a large deposit of coarse, sharp, gray sand that is distinctly stratified This sand by itself lacks binder and hence does not make a molding sand Mixed with the loam at the top, however, it has adequate strength and is well suited for castings These pits were opened about 1917

The loam at the top is similar to the fine material at Delhi and appears to have had a similar origin The underlying sharp, gray sand looks very much like a water deposit (it faces the Miami River), but it may have been transported and deposited by the wind

MOLDING SANDS IN BUTLER COUNTY

The molding sand of Butler County lies about one and one-half miles northeast of Overpeck, or approximately 6 miles from Hamilton Following is a section taken in the pit of the Buckeye Molding Sand Co , on the John Letschke farm

Soil	1 ft
Molding sand	3
Sharp sand	10-15

The molding sand, which varies in thickness from 2 to 4 feet, has a brown color and is without stratification Pebbles up to one inch in diameter are common The material is used in the foundry at Overpeck, and also trucked to Hamilton, where much of it is shipped by rail to Cincinnati, Columbus, Cleveland, and several places in Indiana The material is not milled It is used for gray iron castings, which weigh from 100 pounds to 40 tons

The deposit lies in the angle between Four Mile Creek and the Miami River at an elevation of 640 feet It is a silt that was deposited by those streams when the territory was a flood plain The Buckeye Company has a lease on 40 acres and has worked the deposit approximately 10 years Sand of like quality is now worked on an adjacent farm Similar material is reported to have been gotten near Four Mile Creek about 30 years ago

MOLDING SAND SCREEN TESTS

	Over 10 mesh	Between 10 and 20 mesh	Between 20 and 30 mesh	Between 30 and 40 mesh	Between 40 and 50 mesh	Between 50 and 60 mesh	Between 60 and 80 mesh	Between 80 and 100 mesh	Over 100 mesh	Average Fineness
Sand from Shenk farm near Soldiers Home, Erie County	13	20	22	29	39	51	2 33	86	95 07	97 72
Sand from Mason farm, 2½ miles south of Milan, Erie County	15	1 05	2 27	7 62	9 54	10 12	19 51	2 53	47 21	72 66
Sand from Mason farm, 2½ miles south of Milan, Erie County	07	1 18	3 83	7 82	12 92	10 32	18 21	1 33	44 32	69 87
Sand from Russell farm, Parkertown, Erie County	00	12	23	36	97	1 23	4 46	1 28	91 35	96 22
Sand from Gordon farm, Conneaut, Ashtabula County	35	69	82	57	61	67	1 51	85	93 93	96 50
Ayers Mineral Co No 3 Sand, South Zanesville, Muskingum County	1 68	2 61	5 23	39 26	01	12 05	11 29	72	27 15	53 61
Central Ohio Sand & Gravel Co No 2 Sand, near Dresden, MuskingumCo	03	18	1 30	4 57	4 42	4 47	7 58	1 53	75 92	87 34
Zanesville Sand Co No 1 Sand, Zanesville, Muskingum County	00	02	11	09	26	12	1 13	11	98 16	99 14
Zanesville Sand Co No 2 Sand, Zanesville, Muskingum County	00	01	04	51	5 62	11 95	23 62	5 77	52 48	79 65
Zanesville Sand Co No 3 Sand, Zanesville, Muskingum County	00	02	11	1 37	5 17	13 37	22 70	5 98	51 28	78 87
New Lexington Sand Co No 5 Sand, New Lexington, Perry County	49	99	8 52	30 21	20 78	7 23	7 76	66	23 36	51 34
Jones Bros. Sand Co No. 5 Sand, Goston, Perry County	02	2 02	33 25	33 34	12 33	3 84	3 62	21	11 37	37 42

SURFACE PLANKTON PROTOZOA FROM LAKE ERIE IN THE PUT-IN-BAY REGION

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INTRODUCTION

The observations recorded in the present paper were made during the summer of 1920, from July 7th to August 1st, at the Lake Laboratory, maintained at Put-in-Bay, Ohio, by Ohio State University The writer is indebted to Dr F H Krecker for help in selecting and procuring collecting apparatus and to Dr R C Osburn for helpful encouragement

DESCRIPTION OF THE COLLECTING STATIONS

Collections were made (1) from the open lake, (2) from Put-in-Bay, in the vicinity of the United States Bureau of Fisheries buildings, from July 7th until July 22 only, and (3) from Terwilliger's Pond throughout the period of study

In the open lake, the bottom mud was hard Larger vegetation was absent The algæ, *Pediastrum*, *Tabellaria* and *Asterionella* were plentiful Diatoms also occurred in large numbers

Where collections were made from Fishery Bay, as the second station will be termed, the water was about eight feet deep The bottom mud was hard The same algæ and diatoms were present as in the open lake During the first part of July, the larger vegetation was lacking, but toward the end of the month, a great quantity of eel grass and a small quantity of *Myriophyllum* were present near the Bureau of Fisheries docks

Terwilliger's Pond is about 100 yards long by 75 yards wide The average depth is two feet The bottom was covered with soft mud *Myriophyllum* and eel grass were abundant

The former reached the surface in a number of places during the latter part of July The shore sloped gradually and there were many floating tree trunks in the water and along its edge The pond was well lighted throughout the day It was well protected from the wind because the surrounding land was considerably higher and covered with trees Even when Fishery Bay and the lake were rough, the surface of Terwilliger's Pond was only slightly disturbed

Fig 1—Terwilliger's Pond

Fig 2—Entrance to Terwilliger's Pond

At one end, Terwilliger's Pond is connected with Fishery Bay by a channel about fifteen feet wide The current in this channel reversed every eight to fourteen minutes These intervals were of longer duration when a large boat came into the bay

Water snakes, turtles and fish were plentiful in the pond

FIG 3—Fishery Bay

TABLE I

Shows the Transparency and Temperature Variations of the Three Stations

	TEMPERATURE	TRANSPARENCY
Open lake	22 24 degrees	3 ft —3 ft 6 in
Fishery Bay	22—25 degrees	2 ft —3 ft 6 in
Terwilliger's	20—28 degrees	9 in 17 in

PLANKTON

The Protozoa found in the plankton may be separated into two groups, namely (a) those forms which are large enough to be captured readily with a regular plankton net whose straining surface is made of bolting cloth, and (b) those forms which are so small that they readily pass through the meshes of this bolting cloth The former constitutes the net plankton and the latter is called the nannoplankton

Net Plankton Methods

Identifications were made from the living material only Twenty-four gallons (approximately one cubic meter) of water from the upper foot, were poured through a silk plankton net and the Protozoa in this amount of tow were counted as follows one drop of tow was found to be equal to one-tenth of a cubic centimeter The Protozoa were enumerated by placing a drop (one tenth cubic centimeter) of tow on a slide and, by means of a mechanical stage and compound microscope, the organisms present were counted This number multiplied by ten gave the equal of one cubic centimeter and this number multiplied by the number of cubic centimeters of tow gave the approximate number of organisms per cubic meter of water

Nannoplankton Methods

To determine the number of nannoplankton Protozoa, one-half gallon of the water which had passed through the plankton net, was filtered through hard surface filter paper The filtered organisms were carefully washed from the paper, the volume of the wash water containing the organisms was taken, and the samples of it were then used for enumeration Even with the best quality of hard surface filter paper, many individuals must have become embedded in the meshes so firmly that they could not be washed out The method of counting was the same as that used for the net plankton

The filter method was a very slow one Two hours were required to filter one-half gallon of water

List of Surface Plankton Protozoa

The forms observed during the brief period of study numbered 66 The greatest number, 59, was listed from Terwilliger's Pond, 23 forms came from Fishery Bay and 18 forms from the open lake

The Protozoa were distributed as follows among the groups 27 flagellates, 25 ciliates and 14 rhizopods

Juday (1921) called attention to the fact that the quantity of plankton is not so large per unit of surface in the shallower water as it is in the deeper water, but the larger bottom population in the former region tends to counterbalance the deficiency when the question of the total production is considered The writer did not find this to be so in the case of surface plankton Protozoa The number of forms from the surface of the shallow pond, Terwilliger's, outnumbered those in Fishery Bay by 36 and those in the open lake by 41 One exception may be cited The rhizopod, *Difflugia lobostoma* Ehr, was more numerous in surface plankton catches from the open lake and Fishery Bay than it was in the pond

Rhizopoda

Actinophrys sol
Ameboid forms
Arcella vulgaris
Centropyxis aculeata
Cyphoderia ampulla
Difflugia acuminata
Difflugia corona
Difflugia lobostoma
Difflugia lucida
Difflugia pyriformis
Euglypha ciliata
Heterophrys (?)
Heterophrys myriapoda
Raphidiophrys viridis

Mastigophora

Anthophysa vegetans
Ceratium longicorne
Cryptomonas ovata
Dinobryon sertularia
Distigma proteus
Eudorina elegans
Euglena spp
Euglena (sp?)
Euglena acus
Euglena deses
Euglena spirogyra
Euglena viridis
Gonium pectorale
Pandorina morum
Peranema trichophora.
Peridinium (sp?)
Peridinium tabulatum
Phacus longicaudus
Phacus pyrum
Phacus triqueter
Platydorina caudata
Trachelomonas acuminata
Trachelomonas armata
Trachelomonas caudata
Trachelomonas hispida
Trachelomonas volvocina
Volvox aureus

Ciliata

Amphileptus anser
Aspidisca costata
Blepharisma musculus
Cinetochilum margaritaceum
Codonellacratera
Coleps hirtus
Colpoda (sp?)
Cyclidium glaucoma
Dileptus gigas
Frontonia (sp?)
Frontonia acuminata
Glaucoma scintilans
Halteria grandinella
Holophyra lieberkuhnii
Loxodes rostrum
Oxytricha (sp?)
Pleurotricha grandis
Prorodon armatus
Rhabdostyla sphaeroides
Stentor caeruleus
Trachelius ovum
Uroleptus piscis
Vorticella (sp?)
Vorticella brevistyla
Vorticella microscopica

RHIZOPODA

1 *Actinophrys sol* Ehr Terwilliger's pond This pond was plentiful in only two tows, one made at night and the other at 9 o'clock in the morning

2 Ameboid forms were abundant in the open lake and Fishery Bay between July 8 and 16 During the entire month, they occurred spasmodically in very large numbers in the pond The largest numbers were present in the filter paper catches

3 *Arcella vulgaris* Ehr An occasional individual was seen in water from the open lake and Fishery Bay Small numbers were taken in Terwilliger's pond throughout the latter part of July

4 *Centropyxis aculeata* Stein Only a very few were taken at different times at each of the three collecting stations

5 *Cyphoderia ampulla* Leidy One individual was identified from Fishery Bay

6 *Difflugia acuminata* Ehr One occurred occasionally in Fishery Bay and Terwilliger's Pond

7 *Difflugia corona* Wallich This form occurred in small numbers in one collection from the open lake and at almost the same time in one catch in Fishery Bay It occurred regularly in small numbers in Terwilliger's Pond throughout the period of study

8 *Difflugia lobostoma* Ehr Occurred regularly throughout the period of study in considerable numbers from all three stations The numbers of this species taken from Terwilliger's Pond were somewhat greater than from the other two stations The most individuals occurred in filter paper catches Many were seen to conjugate One of the individuals extruded protoplasm, a large mass of it containing much water The protoplasm after remaining relatively motionless for a time, became active

9 *Difflugia lucida* Penard Plentiful in two tows made in succession at six o'clock in the afternoon and at four o'clock in the morning Most of them were found in the filter paper catch

10 *Difflugia pyriformis* Perty A very few were taken in one tow from Terwilliger's Pond

11 *Euglypha ciliata* Ehr Two individuals were recorded from Terwilliger's Pond

12 *Heterophrys* (?) Numerous in one net tow from Fishery Bay

13 *Heterophyrys myriapoda* Archer One was taken in a collection made under the bridge connecting Terwilliger's Pond with Fishery Bay

14 *Raphidiophrys viridis* Archer One taken in Fishery Bay

MASTIGOPHORA

15 *Anthophysa vegetans* Muller Numerous in filter paper catches from Terwilliger's Pond

16 *Ceratium longicorne* Perty A considerable number in one tow from the open lake A few individuals in each of three collections from Fishery Bay An occasional one from Terwilliger's Pond

17 *Cryptomonas ovata* Ehr Numerous in one filter paper catch from Terwilliger's Pond A few others in another catch from the same station

18 *Dinobryon sertularia* Ehr A very few in one tow from the open lake Somewhat more numerous in scattered collections from Terwilliger's Pond

19 *Distigma proteus* Ehr One from Terwilliger's Pond

Eudorina elegans Ehr Common in all collections from Fishery Bay and the open lake Abundant at all times from Terwilliger's Pond, but increasing in numbers greatly toward the latter part of July The greatest number occurred in filter paper catches

Euglena spp A few in one tow from Fishery Bay Very abundant throughout the period of study in Terwilliger's Pond

Euglena sp (?) A few in one tow from the open lake Abundant in filter paper collections, fewer numbers in the silk net, in all tows made throughout the period of study

Euglena acus Ehr Only a few individuals in scattered collections from Terwilliger's Pond None recorded during the last few days in July

Euglena deses Ehr One specimen from Terwilliger's Pond

Euglena spirogyra Ehr One specimen from Fishery Bay One from the open lake Frequent in several tows from Terwilliger's Pond

Euglena viridis Ehr Frequent in scattered tows from Terwilliger's Pond

Gonium pectorale Mull Four colonies recorded from Terwilliger's Pond

Pandorina morum Bory Very frequent in two tows made in the open lake and Fishery Bay Moderately abundant during the first part of July in Terwilliger's Pond Exceedingly abundant in the same place during the latter part of July In tows made on July 16, 24 and 26, a very large number of young colonies was noted after which, the number of this species reached its height on July 27 Young colonies occurred frequently in one tow from Fishery Bay

Peranema trichophorum Ehr One specimen from Terwilliger's Pond

Peridinium sp (?) Numerous once in surface tow from Terwilliger's Pond on July 28

Peridinium tabulatum Ehr An occasional one from the open lake and Fishery Bay Frequent irregularly during the latter part of July in Terwilliger's Pond

Phacus longicaudus Ehr Frequent in two filter paper catches from Terwilliger's Pond

Phacus pyrum Ehr Frequent irregularly in Terwilliger's Pond during the first part of July

Phacus triqueter Ehr Frequent in Terwilliger's Pond during the latter part of July

Platydorina caudata Kofoid A few colonies in all tows from Terwilliger's Pond during the latter part of July

Trachelomonas acuminata Schmarda One specimen from Fishery Bay Numerous in nearly all of the tows from Terwilliger's Pond, increasing greatly in numbers during the latter part of July

Trachelomonas armata Ehr A few in three filter paper catches from Terwilliger's Pond

Trachelomonas caudata Ehr Three from Terwilliger's Pond

Trachelomonas hispida Stein A very few in two tows from Fishery Bay Abundant during the first part of July in filter apper catches and increasing in numbers past the middle of the month Decreasing somewhat in number toward the end of July

Trachelomonas volvocina Ehr Numerous in two filter paper catches from Terwilliger's Pond

Volvox aureus Ehr One colony from the open lake Numerous colonies throughout the period of study in Terwilliger's Pond Most of them were taken in the silk net

CILIATA

Amphileptus anser Ehr One specimen taken in Terwilliger's Pond

Aspidisca costata (Duj) Several in a few tows from Terwilliger's Pond

Blepharisma musculus Ehr Synonymous with *Uroleptus musculus* Ehr of Butschli A few scattered ones from Terwilliger's Pond

Cinetochilum margaritaceum (Ehr) Three recorded from Terwillig' er's Pond

Codonella cratera (Leidy) A few from the open lake during the first two weeks of July More numerous in tows from Fishery Bay, mostly in filter paper catches Abundant in Terwilliger's Pond collections Considerably more numerous in the tows made at night

Coleps hirtus Ehr Few in the silk net and numerous in filter paper catches from Terwilliger's Pond This form occurred more or less spasmodically

Colpoda sp (?) Frequent in one tow made in the first part of July in Terwilliger's Pond An occasional individual after that and frequent again during the latter part of July

Cyclidium glaucoma Ehr Two from the open lake Numerous in one filter paper catch from Terwilliger's Pond

Dileptus gigus C & L One from Fishery Bay One in a night tow from Terwilliger's Pond

Frontonia sp (?) A few specimens in a filter paper catch from Terwilliger's Pond

Frontonia acuminata Ehr A few in one tow from Terwilliger's Pond

Glaucoma scintillans Ehr A few in two tows from the open lake More frequent in Fishery Bay

Halteria grandinella O F Mull An occasional individual in Terwilliger's Pond until the latter part of July, when the filter paper catches contained a few more

Holophrya lieberkuhnii A few in one Terwilliger's Pond tow

Loxodes rostrum Ehr Numerous individuals in one filter paper catch made at night from Terwilliger's Pond, during the first part of July No more were seen again until the latter part of July when a few were noted from the same place in a night tow

Oxytricha sp (?) Conn A few occurred in two collections from Terwilliger's Pond

Pleurotricha grandis Stein One specimen in a night tow from Terwilliger's Pond

Prorodon armatus C & L One specimen from Terwilliger's Pond

Rhabdostyla sphæroides From One was taken in a tow from Fishery Bay

Stentor cæruleus Ehr Frequent in one tow from Fishery Bay

Trachelius ovum Ehr A few specimens from Terwilliger's Pond

Vorticella sp (?) An occasional specimen in night tows from Terwilliger's Pond

Vorticella brevistyla D'Udk One from the open lake

Vorticella convallaria Linn , (Kent) A single specimen was recorded from Terwilliger's Pond

Vorticella microscopica From A single specimen occurred in a night tow made in Terwilliger s Pond

PLANKTON TABLES

FISHERY BAY Surface Plankton Protozoa Numbers are per cubic meter	Sky black water very rough Transp 3 5″ Temp 22° July 7 9 A M		Sky clear water calm slight breeze Temp 24° July 12 11 P M		Bright sunlight water rippled Preceding day heavy rainstorm Transp 1 5 Temp 24 July 15 9 A M		Bright sunlight Preceding day very rough Transp 3 6 Temp 24° July 16 4 P M		Heavy clouds Water rough Much rain preceding day Transp 2 Temp 22° July 19 11 A M		Bright sunlight water rippled Preceding day calm Transp 3 Temp 24° July 21 11 A M	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Ameboid forms minute	324000	825600	1200	24000	13200	10200	2040					
Arcella vulgaris Ehr									1			
Centropyxis aculeata Stein	30											
Cyphoderia ampulla Leidy									1			
Difflugia acuminata Ehr			1									11520
Difflugia corona Wallich							120				1	
Difflugia lobostoma Ehr	1020	2400	10200	25000	3190		13080		2600	14400	1430	8000
Euglypha ciliata Ehr									1			
Heterophrys (?) developmental forms(?)							120900					
Raphidiophrys viridis Archer									1			
Ceratium longicorne Perty		1	100	100							720	
Eudorina elegans Ehr		2400	500	1000	110		1560					3840
Euglena spp	60	10200									1	1
Euglena spirogyra Ehr											1	
Pandorina morum Bory				9600			2040				110	19200
Peridinium tabulatum Ehr			2									
Trachelomonas acuminata Schmarda											1	
Trachelomonas hispida Stein											110	
Codonella cratera Leidy	60	9600	700	10200	110		120				330	
Dileptus gigas C & L												
Glaucoma scintillans Ehr	360	4800	500	52800			600					
Rhabdostyla sphaeroides From			1									
Stentor caeruleus Ehr									200			

* Young colonies

PLANKTON TABLES—Continued

TERWILLIGER'S POND Surface Plankton Protozoa Numbers per cubic meter	Sky black water very rough Transp. 15.5" Temp. 22.5° July 8 9 A M		Sky clear water calm Temp. 26° July 13 10 P M		Bright sun light water disturbed by a stiff breeze. Transp. 9" Temp. 25° July 15 9 A M		Bright sun-light water calm. Transp 10" Temp. 28° July 18 4 P M		Sky clouded, preceding day stormy with heavy rains. Water full of silt and disturbed slightly Transp 9" Temp. 23° July 19 11 A. M	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Actinophrys sol Ehr										
Ameboid forms minute.	12000	1800000			235	10000				
Arcella vulgaris Ehr									280	
Centropyxis aculeata Stein	33								1	
Difflugia acuminata Ehr										
Difflugia corona Wallich.			200		1		240		280	
Difflugia lobostoma Ehr	1100	2600	1700	14400	2492	25000	23040	6000	4060	19400
Difflugia lucida Penard										
Difflugia pyriformis Perty							480			
Euglypha ciliata Ehr									1	
Heterophrys myriapoda Archer										
Anthophysa vegetans Mull		13000								
Ceratium longicorne Perty										
Cryptomonas ovata Ehr										
Dinobryon sertularia Ehr								6000	280	
Distigma proteus Ehr									1	
Eudorina elegans Ehr	19000	97500	600		4781	20000	2640	24000	1400	36000
Euglena spp	600	227500					720	48000	4320	771840
Euglena sp (?)	200	26000	100		8032	300000			5180	25800
Euglena acus Ehr	33	3250			96					11520
Euglena deses Ehr										
Euglena spirogyra Ehr	66	6500			191	2	480		280	51840
Euglena viridis Ehr	33	3250				1000				
Gonium pectorale Mull									1	
Pandorina morum Bory	1300	110500	200		5068	75000	25920	438000	2040	372000
Peranema trichophorum Ehr										
Peridinium sp (?)										
Peridinium tabulatum Ehr										
Phacus longicaudus Ehr						1000				11520
Phacus pyrum Ehr		3250							140	11520
Phacus triqueter Ehr		19500			287				280	66060
Platydorina caudata Kofoid										
Trachelomonas acuminata Schmarda	100	58500		15000			720	36000	7980	504000
Trachelomonas armata Ehr						1000			140	5760
Trachelomonas caudata Ehr									1	2
Trachelomonas hispida Stein.		39000		1	287	35000	240	18000	140	80640
Trachelomonas volvocina Ehr										
Volvox aureus Ehr	3				670	1	960		420	3
Amphileptus anser Ehr										
Aspidisca costata (Duj)										1
Blepharisma musculus Ehr										
Cinetochilum margaritaceum Ehr								2		
Codonella cratera (Leidy)	200	19500	10300	220000	1912	15000	960	18000	3920	132480
Coleps hirtus Ehr			800	55000			240		280	149760
Colpoda sp. (?)	400	19500	300							
Cyclidium glaucoma Ehr				15000						
Dileptus gigas C & L				1						
Frontonia sp (?) Conn										
Frontonia acuminata Ehr										
Hatteria grandinella O F Mull						1	1			1
Holophrya lieberkuhnii										
Loxodes rostrum Ehr										
Oxytricha sp (?) Conn.										
Pleurotricha grandis Stein.										
Prorodon armatus C & L	1									
Trachelius ovum Ehr										
Vorticella sp (?)										
Vorticella convallaria Linn										
Vorticella microscopica From				1						

PLANKTON TABLES—Continued

TERWILLIGER'S POND Surface Plankton Protozoa Numbers per cubic meter	Sky clear water calm Eel grass surface of pond Transp. 10" Temp. 25° July 21 11 A. M		Bright sunlight atmosphere hazy sultry water rippled Transp. 9" Temp. 28° July 23 8 P M		Sky with heavy clouds water rippled. Temp 25° July 23 10 P M		Sky clear water slightly rippled. Temp 24° July 24 4 A M		Sky clear a few white clouds. Atmosphere clear Water rippled Transp 10" Temp. 20.5° July 26 9 A. M		Sky clear Water placid Temp 22° July 26 10 P M	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Actinophrys sol Ehr						19200				800		
Ameboid forms, minute	1000			33600								
Arcella vulgaris Ehr	1		200		100							
Centropyxis aculeata Stein												
Difflugia acuminata Ehr												
Difflugia corona Wallich.	1000		400		400		400				600	1
Difflugia lobostoma Ehr	5000	16500	2600		1400		2000		3400		1000	14400
Difflugia lucida Penard												
Difflugia pyriformis Perty											1	
Euglypha ciliata Ehr												
Heterophrys myriapoda Archer												
Anthophysa vegetans Mull		22000		4800		9600						
Ceratium longicorne Perty			1						1		1	
Cryptomonas ovata Ehr												
Dinobryon sertularia Ehr		1 col	800									
Distigma proteus Ehr												
Eudorina elegans Ehr	4200	27800	13800	67200	3400	28800	87800	28800	14200	129600	2400	139200
Euglena spp	7800	577500	6400	105600	200	9600		1	4200	307200	1	1
Euglena sp (?)	6600	49500	7000	4800	1400				400	4800		
Euglena acus Ehr			1									
Euglena deses Ehr	1											
Euglena spirogyra Ehr							1		600	9600		
Euglena viridis Ehr	1800	16500										
Gonium pectorale Mull			2	1								
Pandorina morum Bory	3200	275000	7600	86400	1200	48000	117800	76800	17800	129600	2400	158400
Peranema trichophorum Ehr									1			
Peridinium sp (?)												
Peridinium tabulatum Ehr				1						800		
Phacus longicaudus Ehr									1	1		
Phacus pyrum Ehr		5500		4800								
Phacus triqueter Ehr		5500		4800					200			
Platydorina caudata Kofoid									200	1		
Trachelomonas acuminata Schmarda	3600	77000	9800	33600		9600			5200	100800	400	
Trachelomonas armata Ehr		61000										
Trachelomonas caudata Ehr												
Trachelomonas hispida Stein.	2000	181500	600	4800	200				200	4800		960
Trachelomonas volvocina Ehr												
Volvox aureus Ehr	6		1600		1200		800		800		400	9
Amphileptus anser Ehr	1											
Aspidisca costata (Duj)			1		200			9600				336
Blepharisma musculus Ehr		1						96				
Cinetoc hilummargaritaceum (E)												
Codonella cratera (Leidy)	5400	11000	3000	4800	4800	28800	9000	76800	4200	43200	1000	72000
Coleps hirtus Ehr			400	4800	400		800	9600		1		
Colpoda sp (?)		1		1		9600	200	9600				
Cyclidium glaucoma Ehr												
Dileptus gigas C & L												
Frontonia sp (?) Conn.			200									
Frontonia acuminata Ehr												
Halteria grandinella O F Mull										1		
Holophrya lieberkuhnii												
Loxodes rostrum Ehr											300	144
Oxytricha sp. (?) Conn						96						
Pleurotricha grandis Stein.												
Prorodon armatus C & L.												
Trachelius ovum Ehr										1		
Verticella sp (?)						1		1				528
Vorticella convallaria Linn								1				
Vorticella microscopica From												

PLANKTON TABLES—Continued

TERWILLIGER'S POND Surface Plankton Protozoa Numbers per cubic meter	Sky clear water placid Rays of sun not yet striking pond Transp 16" Temp 20.5° July 27 5 30 A M		Sun shining through white clouds Atmosphere hazy Transp 16" Temp. 24 July 28 11 30 A M		Sky with light clouds. Atmosphere hazy Water placid Transp 17" Temp 26 July 28 6 P M		Sky clear water undisturbed Temp 24° July 29 4 A M		Sky clear water slightly rippled Under bridge Current going out of pond. Transp 16 Temp 23° July 30 10 A M		Under bridge Current entering pond July 30 10 A M	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Actinophrys sol Ehr												
Ameboid forms minute						96000	150					
Arcella vulgaris Ehr							300		39			
Centropyxis aculeata Stein							225				30	
Difflugia acuminata Ehr							2	1				
Difflugia corona Wallich	400				120		300		52		120	
Difflugia lobostoma Ehr	400	144	400		5820	48	1800	96	1300		1800	48
Difflugia lucida Penard					2000	14400	525	10560				
Difflugia pyriformis Perty												
Euglypha ciliata Ehr												
Heterophrys myriapoda Archer											1	
Anthophysa vegetans Mull												
Ceratium longicorne Perty							1		2	1		
Cryptomonas ovata Ehr			50	38400	120							
Dinobryon sertularia Ehr	1			1	1							
Distigma proteus Ehr												
Eudorina elegans Ehr	400	144	400		5520	48	1800	96	1300		1800	48
Euglena spp	1	192	1000	7080	4000	388800	225		260	28800	180	17280
Euglena sp (?)						48						
Euglena acus Ehr												
Euglena deses Ehr												
Euglena spirogyra Ehr	1	1							1			
Euglena viridis Ehr												
Gonium pectorale Mull												
Pandorina morum Bory	15400	1103680	1000	48000	1800	940800	3300	227040	910	64900	480	30240
Peranema trichophorum Ehr												
Peridinium sp (?)					1080	38400						
Peridinium tabulatum Ehr			200	9600								
Phacus longicaudus Ehr												
Phacus pyrum Ehr				1								
Phacus triqueter Ehr												
Platydorina caudata Kofoid			20		400	96	150	48	85			
Trachelomonas acuminata Schmarda	800	19200	800	38400			150		130	21600		
Trachelomonas armata Ehr												
Trachelomonas caudata Ehr												
Trachelomonas hispida Stein	200	9000	1000	44200	120	24000	150			48		
Trachelomonas volvocina Ehr												
Volvox aureus Ehr	600		400		1320		75				1	
Amphileptus anser Ehr												
Aspidisca costata (Duj)												
Blepharisma musculus Ehr			25	1	120				1			
Cinetochilum margaritaceum (E)												
Codonella cratera (Leidy)	2200	38400	1600	14400	3600	192	5400	26400	130		600	
Coleps hirtus Ehr						48						
Colpoda sp (?)						624	150					
Cyclidium glaucoma Ehr												
Dileptus gigas C & L												
Frontonia sp (?) Conn												
Frontonia acuminata Ehr						100						
Halteria grandinella O F Mull						1776		96		48		
Holophrya lieberkuhnii						144						
Loxodes rostrum Ehr								48				
Oxytricha sp (?) Conn										48		
Pleurotricha grandis Stein.							1					
Prorodon armatus C & L												
Trachelius ovum Ehr						96						
Vorticella sp (?)			1			48		1	3			1
Vorticella convallaria Linn												
Vorticella microscopica From												

PLANKTON TABLES—Continued

OPEN LAKE Surface Plankton Protozoa Numbers are per cubic meter	Sky black, water very rough. Transp. 3' 5" Temp 22° July 7 8 A. M		Sky clear water calm very slight breeze. Temp. 23° July 12 10:30 P M		Bright sunlight, water very rough Transp. 3' 5" Temp. 23° July 15 9 A. M		Bright sunlight water very calm. Transp. 3' 6 Temp. 23° July 16 4 P M		Bright sunlight long rolling Waves. Transp. 3' Temp. 24° July 21 11 A. M	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Ameboid forms, minute	Abdt.	Abdt.	6000		3000	145000				
Arcella vulgaris Ehr			1		1					
Centropyxis aculeata Stein		1								
Difflugia corona Wallich.					100					
Difflugia lobostoma Ehr	1120	24000	5200		2700	15000	4060		1200	6720
Ceratium longicorne Perty	70	1440								
Dinobryon sertularia Ehr	6									
Eudorina elegans Ehr	210	14400	900			35000	960		480	3360
Euglena sp (?)		6240								
Euglena spirogyra Ehr		1								
Pandorina morum Bory		2880								20160
Peridinium tabulatum Ehr					2		240			
Phacus pyrum Ehr	1									
Volvox aureus Ehr		1								
Codonella cratera (Leidy)	18	2880	100		100		240			
Cyclidium glaucoma Ehr	2									
Glaucoma scintillans Ehr			300		100	25000				
Vorticella brevistyla D Udk.	1									

OBSERVATIONS ON THE DIURNAL MIGRATION OF THE SURFACE PLANKTON PROTOZOA

It is interesting to note that in the tow made at 10 P M, July 12, at 11 P M, July 23, at 4 A M, July 29, and at 10 P M, July 30, the predominating Protozoa were rhizopods and ciliates, in other words, they were mostly holozoic forms A few colonial flagellates that were so abundant in the water during the day time were present only in small numbers in the night tow

The ciliates, *Codonella cratera* (Leidy) and *Coleps hirtus* Ehr, occurred much more abundantly in night tows than in tows made during the day time

I believe that it can be said that the chlorophyll bearing forms were present in greatest numbers at the surface between three and five o'clock in the afternoon

It may be noted that in the collections made under the bridge connecting Terwilliger's Pond and Fishery Bay, the tow made while the water flowed out of the pond contained more than twice as many protozoan organisms as the tow made while the current flowed from Fishery Bay into the pond

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STUDIES OF THE BIOLOGY OF FRESHWATER MUSSELS

II THE NATURE AND DEGREE OF RESPONSE TO CERTAIN PHYSICAL AND CHEMICAL STIMULI *

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1 INTRODUCTION

During the progress of studies upon the nature of the food of the Unionidæ (Allen 14) it became important to know what power of food selection is exercised Such selection involves the possession of sensory nerve endings in the epithelia The writer has attempted to demonstrate the nerve endings in the various epithelia by two methods—histological and experimental Histological methods have so far been almost wholly unsuccessful insofar as revealing the qualitative arrangement of the several types of nerve endings is concerned The experimental method as applied to the study of the control of ingestion has been much more profitable (Allen '21, 1) The present paper embodies the observations made during the same time upon the effects of stimulation of the several regions of the mussel epithelium which are normally exposed

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*Contribution from the Zoological Laboratory of Indiana University No 192

The mussels used in this work were the species commonest in Winona Lake, Indiana, and in the White River at Gosport and Shoals, Indiana From the lake were obtained *Anodonta grandis* and *Lampsilis luteolus*, from White River, *Quadrula heros*, *Q pustulosa*, *Q lachrymosa*, *Q undulata*, *Unio crassidens*, *U gibbosus*, *Lampsilis ligamentinus*, *L alatus*, *Plagiola elegans*, and others

The methods of study will be outlined under each respective heading in the body of the paper For convenience they will be grouped first as to their chemical or physical nature

2 THE SENSORY EPITHELIA

The exposed soft parts of an extended mussel are the foot, mantle edge, and siphons That they bear more highly sensory epithelia than those enclosed within the shell is easily shown by experiment

The *foot* is of course largely muscular Numerous blood sinuses lie beneath its epithelium and cover the muscular portion The sinuses diminish toward the ventral margin of the foot, and where they occur the foot is most sensitive to tactile stimuli

With the gaping of the shell to allow for the protraction of the foot, open spaces anterior and posterior to the foot would be formed were it not that the *mantle* is adapted for closing the apertures It is inserted into the shell parallel to its margin, in the pallial line The edge of the mantle distad to this line is muscular, and the muscular zone of the right and left mantle lobes respectively are projected beyond the edge of the valves until they meet in the median line The deep-burrowing sedentary *Lampsilis anodontoides* produces furthermore a considerable overgrowth of periostracum which answers the same purpose when the mantle is retracted

The *siphons* are by no means so well developed nor so deserving of the name as in some of their marine relatives

Compared with the general mantle margin, they are more muscular, slightly more protractile, and possess a greater innervation In many marine species the mantle edges are sufficiently united to constitute closed tubes But the freshwater forms (Sphaeriidæ excepted) have the mantle edges united only at one point—i e, their junction with the suprabranchial septum, thus separating the dorsal and ventral siphons

The siphons differ from the subjacent general mantle edge in the possession of papillæ The dorsal siphon tends to have a single row of small papillæ, while the ventral has two or three rows of much larger ones By means of these the sensory surface is much increased

3 Physical Stimuli

Many details of the following experiments will be omitted, for the sake of summarizing numerous experiments in few pages, and to secure continuity and clearness

(a) *Mechanical, or Tactual, Stimuli*

The effects of contact of the siphons, mantle edge, and foot with objects of various character were noted A dissecting needle, camel's hair brush, and wooden spatula were used for their varying size, hardness and sharpness They were brought into contact with a greater or less surface, with greater or less impact, and for greater or less lengths of time

(1) *The Foot*

Upon the muscular portion of the foot a needle-point produces an unappreciable local effect, simply a depression of the area surrounding the point touched At times of low activity the foot may even be pricked without a very considerable retraction If a long time (30 seconds or more) elapses between stimuli, the same point may be touched repeatedly without additional result However, when the same point or adjacent points are repeatedly stimulated at rapid intervals, the foot may be withdrawn to a considerable extent This again depends upon temperature, oxygen supply, etc Those individuals which are well fed, which have been living in well ærated water, and in water of 18° to 25° C react more readily to all stimuli than do those under other conditions Extremely unfavorable state of the water may result in a mussel's tendency to lie prone with the foot extended and mantle gaping

The camel's hair brush is incapable of initiating more than local movements The spatula produces a wider response than does the needle point The larger, then, the surface stimulated the more profound is the response Repeatedly touching with the spatula soon causes the foot to retract, sometimes entirely within the shell

The response to two needle points simultaneously is greater when some distance apart, but not so great as that produced by the spatula

(2) *The Mantle Edge*

The mantle margin is more sensitive than the foot A gradation from the middle, both forward and backward, is perceptible That is the poorest innervation occurs near the middle of the mantle in the portion near the foot Toward the two extremities it becomes more sensitive

The camel's hair brush, needle, etc produce a marked response when touched to the mantle edge, and the spatula still greater effect Not so many repetitions of a stimulus or so vigorous contact is required as upon the foot The stimulus of one contact is held over for a longer time than on the foot, while a second or third increases the effect Repeated or vigorous stimulation causes a discharge of water from the mantle chamber by adduction of the shell, and when kept up may incite burrowing

(3) *The Siphons*

A minimum of stimulation produces a maximum of response when applied to the siphons The camel's hair brush is as effective as the needle point Contact with a single papilla results usually in the retraction of the papilla alone A repetition at intervals may cause the adjacent region of the siphon to draw back Only a considerable impact upon a single papilla can cause the siphons to close or cause a discharge of water from the mantle chamber Of course in this case the thrust is transmitted through the papilla to the surrounding mantle, and other nerve endings are affected.

The result is greatly amplified when two or three papillæ are stimulated together or in close succession The nearby portion of the siphon is drawn back sharply, and repetition may cause the discharge of water Often also there is a readjustment of posture, and more or less burrowing may follow

If the contact is sufficiently vigorous upon either ventral or dorsal siphon, both close Yet a slighter pressure upon the ventral siphon is required than upon the dorsal to cause the closure of both This is as might be expected The ventral opening is the larger and it receives the incurrent stream For both reasons it should be well guarded Mussels are often seen to hold the tips of the opposing rows of papillæ together in the median line, thus testing the entering water more thoroughly than when the siphons are wide open There is less likelihood of attack through the excurrent opening against the streaming water

We have reason to conclude that there exist no local reflexes by which the muscles of one siphon are caused to react to a stimulus from receptors of the other Such stimuli probably must pass through the visceral ganglion, for it innervates the two siphons through distinct tracts by way of the pallial nerve

Furthermore, it is easily seen that the two lips of either siphon are without a nerve commissure connecting right with left When a sufficiently slight tactual or chemical stimulus is applied to one side of a siphon, that side alone gives a response If the stimulus is increased in magnitude it reaches the visceral ganglion and is transmitted also to the other side of the siphon This involves of course the pallial nerves of both mantles, both hemispheres of the visceral ganglion, and their commissure Local reflexes govern only the muscles of the respective halves of either siphon The fusion of the two siphons with the supra-branchial septum and with each other is very superficial, and has not affected the nerve supply The siphons are not units in a complete morphological sense, but only somewhat differentiated areas of the mantle edge, left and right

The two siphons are, then, differentiated primarily for the admittance and discharge of water In the exercise of these functions they have acquired a further specialization—the ventral in a sensory direction, the dorsal in a motor, for the control of the flow of water The ventral is often observed to stand open, while the dorsal is to a greater or less extent closed Surprisingly the sense organs of the ventral siphon exercise a more profound and lasting effect upon the dorsal siphon than upon the muscles of the ventral itself, and as a corollary a more profound effect than is produced by the sense organs of the dorsal itself The following sequence of reactions has been secured many times

1 Ventral strongly stimulated Both siphons close vigorously Both reopen together

2 Stimulus repeated soon Both siphons close Ventral reopens, then dorsal

3 Stimulus again repeated Dorsal siphon closes Ventral not entirely closed, and reopens at once

Thenceforward there is a greater effect upon the dorsal than upon the ventral The former has the manner of opening cautiously, tentatively If the dorsal siphon is similarly irritated, there comes at last to be some response from the ventral, and a more local, temporary one from the dorsal itself

The parts of the ventral siphon were shown not to be equally sensitive The inner margin, next the lumen, is most responsive The papillæ of the inner circle are longer and larger than the outer ones The latter may sometimes be touched with only a local, temporary effect, while an equal contact with the inner or marginal papillæ results in a general and vigorous response This should be expected since the marginal papillæ are nearest the inflowing water The dorsal does not show such unequal distribution of the tactile organs

In studying the method of burrowing in *Quadrula undulata* it was observed that the animal employed the papillæ to gauge its depth in the substratum When pulling itself further into the sand, the mantle and siphons were withdrawn more or less out of the way and the valves as closely appressed as possible Alternating with this movement the siphons were extended and the papillæ spread out, some of them upon the sand Without doubt the relation of the papillæ to the substratum, and to the free water above, provide the necessary orientation of the burrowing reflexes

The still more deeply burrowing forms, such as *Plagiola elegans*, withdraw wholly into the sand A little funnel-shaped crater affords communication with the water above The papillæ of the siphons are spread out radially upon the sand at the bottom of this crater They not only aid in holding back the sand, but also warn the animal when it accumulates The response is an adduction of the shell, perhaps repeated, which sweeps out with a jet of water the excess sand and restores its proper equilibrium

(b) *Thigmotropism and Rheotropism*

At this point mention should be made of the mechanical effects of obstructions in the substratum and the thrust of the current

The movements of a mussel, by alternate distension and retraction of the foot and the flow of blood in the serous spaces, suggest amoeboid locomotion Observation has shown also that there is no little resemblance to the thigmotropic reactions of *Amoeba* when obstructions are met with Under conditions in which gravity and current may be disregarded it is learned that a mussel, diverted from its course by a stone or bit of wood, does not revert to the old course, but continues in the new

This avoiding reaction is sometimes the result of inability to draw the shell past the barrier, and sometimes can be explained as an unequal tactual stimulation of the surfaces of the burrowing foot As soon as equilibrium of friction is restored the animal proceeds again, in a new straight line

In running water, if not of too great velocity, mussels often travel in a direct line transversely or obliquely to the current When turned aside they often revert to the former course as soon as an obstruction is passed The angle which their course makes with the current seems somewhat dependent upon the stream velocity It is difficult to determine whether the orientation to the current is due to pressure upon the shell or to friction upon the siphon region

After checking the movements of many individuals in streams it seems very probable that rheotropic reactions may account in part for the grouping of mussels in shoals, as well as for their orientation upon the shoals

A state of approximate equilibrium in the substratum is preferred in streams Where there is too great current eddies tend to develop around the shells of the more emergent species, washing the sand away and loosening their hold

The importance of the above factors in local distribution has been discussed in the third paper of this series (Allen, '21, 2)

(c) *Light and Phototropic Behavior*

The siphon not only has a better innervation, but is also more deeply pigmented than any other part of the mantle This at once suggests light reception as one of its functions Such differentiation of mantle finds its greatest expression, of course, in the more or less complex eyes of the Arcidæ and Pectinidæ Hecht ('21) has defined the physiological aspects of photoreception in *Mya arenaria* and *Ciona intestinalis*

(1) *Light Intensity*

Three sets of experiments were carried out simultaneously in bright sunlight, subdued sunlight, and artificial light respectively The animals were placed either in tubs or aquaria in which water was kept level by siphons, and ærated by dripping tap water A sufficient depth of clean sand was used to allow entire freedom of movement The experimental animals were periodically re-oriented with respect to the sources of light and their new positions and tracks noted—usually once each day In the first experiment aquaria were used, at a south window In the second the tubs stood just far enough from a south window to be out of direct light In the third a 40-watt lamp was lowered into the center of a tub by means of an anchored museum jar of small diameter

Quadrula heros was most useful in these experiments, due to its more frequent and more prompt response This response is in part owing, no doubt, to its habit of turning and resting upon one side Thus when originally placed erect on the sand it has this additional stimulus to incite movement The species has an exceptionally heavy shell When standing erect, hinge upward, it is in rather unstable equilibrium and tends through sheer weight to turn upon one side or the other

It might be suspected that the results were due to the animals' seeking their reclining posture That the stimulus to turn is not wholly due to this factor, but that light also initiates movement is shown in the first experiment by the fact that the response is very much less on cloudy days, and that they did not follow the law of chance in the direction of movement

EXPERIMENT 1 DIRECT SUNLIGHT

Single *Quadrula heros* were set in the center of an aquarium upon clean sand, beneath three or four inches of water, after previously allowing them to become adjusted to that depth They were placed at a south window in direct sunlight throughout the day They were put into an erect, unnatural posture, like that of *Lampsilis* or *Anodonta* The siphons were turned toward the south

The following table is a check upon the several successive occupants of an aquarium for three weeks Possibly on account of shell weight, none failed to burrow after each forced change of posture, although some time always elapsed during which they remained motionless

Date	Amount of turning of siphons in degrees from south	Remarks
May 8	90	
“ 9	180	
“ 10	45	
“ 10	45	Cloudy
“ 13	180	Changed in morning siphons turned eastward
“ 15	00	Very warm, partly cloudy
“ 16	00	Very warm, partly cloudy
“ 17	00	Very warm, partly cloudy
“ 19	90	Change in morning siphons turned eastward
“ 20	90	
“ 21	90	
“ 23	90	
“ 25	90	
“ 27	00	
“ 28	30	Eastward, cloudy forenoon
“ 29	90	

Total avoiding light	11
Total turning toward light.	0
Failure to respond to light	4

After recording each observation the experimental animal was set back to its original position, or another of the same species substituted The reactions of May 15–17 were probably vitiated by the unusually high temperatures, although the water was changed daily

The large number of quarter turns is significant It is especially so since the animals usually turned clockwise, and were found with the siphons pointing westward This is easily explained as an avoidance of the forenoon sun Each experiment began in the evening, too late for the same day's sun to be effective During the night the animal was becoming adjusted to its new position, and remained inactive Not much movement took place until the following morning Consequently the usual turning to the east with the siphons to the west during the forenoon accomplished as great avoidance of the sun as possible During this rotation and following there was also a lateral burrowing movement which resulted in the animal's lying on the left valve, its foot parallel to the surface, and hinge turning northward In this species the siphon is never extended far beyond the shell, and is usually wholly within the shelter of the valves In this position they received the maximum amount of shade in the experimental animals

In order to demonstrate that there is no preference for lying on the left valve, a series of similar experiments were made in the dark The response was much less prompt in darkness Fifteen finally assumed a position on the left side and sixteen on the right

The degree of torsion is seen to be much reduced by cloudy weather The above expression in degrees is of course approximate, for with the accompanying lateral movement exact measurement is difficult Nor is it important

EXPERIMENT 2 SUBDUED SUNLIGHT

In each of two tubs placed in indirect sunlight near the south windows six *Quadrula heros* were stationed The windows of the room were such that the brightest light came into the tubs from the southwest, the least light from the dark southeast corner There was considerable reflected light from the northeast From still greater illumination at the west and northwest the light shaded off toward the east and northeast

Running tap water kept the animals in vigorous condition They were checked up and reset at frequent intervals Those in "tub 1" were placed with the siphons toward the maximum light of the southwest, those of "tub 2" the reverse, with the siphons pointing away from the maximum light, but not toward the minimum of the southeast The following table indicates the reactions over a short period, though the experiment was kept up with modifications from January to the end of May

DATE	TUB 1			TUB 2		
	Remain toward light (Positive)	Turn to south (Negative)	Turn to north (Negative)	Remain toward light (Less Positive)	Turn to south (Negative)	Turn to north (Most Positive)
April 11	1	3	2	1	5	0
" 17	0	4	2	4	2	0
" 23	1	5	0	3	2	1
" 26	3	2	1	2	3	1
" 29	2	4	0	1	5	0
May 2	3	3	0	2	3	1
" 7	4	2	0	1	4	1
Totals	14	23	5	14	24	4
Another experiment using more intense light	4			13		

Total remaining toward light of greatest intensity, but not direct	4
Total remaining toward light of second order of intensity	14
Total remaining toward light of third order of intensity	27
Total reacting positively to light.	4
Total reacting negatively to light	52
Of the last total, turning to north from southwest	5
Of the last total, turning to south (darkest corner)	47

During the winter months the reactions were very slow and much less definite than in spring, though qualitatively similar While it appears probable that there is a sort of hibernation, or seasonal rhythm in metabolism, aside from the effects of the immediate physical surroundings, yet there is no doubt that temperature is largely responsible for the increased activity of April and May

From the above table it will be seen that nearly every day's record shows the directive agency of light Usually a greater number of *Quadrula* reacted negatively to light than the number which failed to move at all A still smaller number turned toward light of greatest intensity It will be noted that the reaction time was much greater in subdued sunlight than in direct Given more time the above predominance of negative reactions would probably have been greater Not only is it significant that there was an avoidance of southwest light, but that nearly all such cases turned the siphons toward the darkest corner of the room—the southeast—and few to the somewhat greater light of the north Of course those which turned from the east to the north were reacting positively, while those which turned from the west to the north were changing the siphons into light of less intensity The supplementary experiment at the end of the above table was an attempt to ascertain the result of using light of an intensity intermediate between Experiments 1 and 2 Equal numbers were used in tubs 1 and 2 In the former only four remained exposed to the greater light intensity, while thirteen remained passively siphoning toward the northeast in the second tub In the totals it may seem inconsistent that the same number (fourteen) should have remained facing either direction This is explained by the fact that the shock of handling or inertia is with difficulty overcome at first Of more significance is the undoubted subsequent orientation with respect to light The original inertia is seen to be overcome most rapidly by light of the greatest intensities

In order to make certain that *Quadrulæ* do not have a preference for lying on the right or left side, a part of the experiment was repeated in darkness The results were Remaining erect, 13, on right side, 13, left side, 14 None were ever observed to change from one side to the other, either after assuming their position voluntarily, or after having been placed arbitrarily Large numbers of observations verify this point It is certain that no other element than light is responsible for influencing the direction of movement in the above experiments

EXPERIMENT 3 ARTIFICIAL LIGHT

In the tub kept in darkness and illuminated by a 40-watt lamp eight mussels of as many species were kept and checked from April 25 to May 27

During the progress of the experiment the mussels were placed variously, having the siphons toward the light, away from it, and at various distances from it of one inch up to about eight inches They were observed and reoriented twenty times in the thirty-two days Being 45° apart in the tub there was room for each to move without interference There being twenty records for each individual, we have a total of 160 records The total number actually changing posture was 61 out of the possible 160 There remain 99 negative results, a ratio of about three to two more or less positive results The following species participated The number of times each moved is indicated *Lampsilis alatus*, 1, *L ligamentinus*, 18, *Quadrula lachrymosa*, 0, *Q pustulosa*, 1, *Q heros*, 9, *Unio crassidens*, 14, *U gibbosus*, 10, *Plagiola elegans*, 8 Average 7 6 out of a possible 20

The above record is not significant, as an analysis of the behavior of the respective species, perhaps, on account of the small number used But we do have a fair test of the average reaction in light of low intensity The fact that *Quadrula heros* only changed position 9 times out of 20, 56 times out of 84 in Experiment 2, and 11 times out of 15 in Experiment 1, show a responsiveness to light that is in the inverse ratio of its intensity

Temperature may be in part responsible It varied between 12° C and 16° C, averaging about 14° C in the third experiment In the second it averaged about 16° C and ranged between 13° C and 17 5° C In the first experiment temperatures were still a little higher, but on the warmest days, which were also very cloudy, there was little response to be seen Thus light was shown to be more pertinent than temperature

Although only 61 out of 160 moved at all in this series of observations, yet only 11 of the 61 turned either toward or away from the light The remaining 50 burrowed directly downward without a reorientation Light evidently had little to do with these movements Even when placed nearly in contact with the source of light there was not a perceptibly greater turning away from it than when separated by the radius of the tub When tried four days in darkness 12 moved and 20 failed to do so, a not very different ratio The above-mentioned reactions of *Quadrula heros* gave 13 out of 40 failing to burrow in darkness

There are other evidences (Allen, '21, 2) that the optimum conditions for mussel life include a moderate amount of light, rather than extreme amounts Light itself has little importance in the life of the organism—its significance lies in the accompanying complex of conditions

(2) *Responses of the Siphons to Rapid Light Changes*

When the mussel has been siphoning undisturbed the siphons respond to changes in light intensity The magnitude of the response is more or less proportionate to the change in light (See also Hecht, '21) If an object is interposed between the sun and the siphons, changing them from a condition of maximum illumination to deep shadow, there occurs a very prompt and complete closing of the siphons A considerable time is then necessary to accustom the siphons to the lower light intensity They slowly and tentatively reopen in the shadow If the shadow is withdrawn, the direct sunlight again causes a closure, and a slow renewal of siphoning again takes place By rapid and repeated changes between sunlight and shadow the siphons are first caused to close, then to draw into the shell, and finally comes an adduction of the valves and spurting of water from the siphons Then normal siphoning is renewed This reaction may be produced several times in succession Usually a burrowing movement, or at least a change of posture, takes place

The same reactions may be gotten in indirect sunlight, especially at a north window, or wherever most of the light comes from a single direction At noon on bright days the response at a north window is not of much less magnitude than in direct sunlight After four o'clock the reactions diminish in magnitude and reach the vanishing point before twilight Very faint shadows elicit no response

In these experiments we again get the maximum of response from mussels which have been kept in running water In standing water not frequently changed the closure of the siphons is not so rapid in bright light, so easily produced in subdued light, nor so quickly repeated on second stimulation The siphons do not close so completely, and reopen more quickly A certain indifference to stimuli, not unlike fatigue, is seen when the water is very impure

As shown above (Experiment 1) the Unionids kept at south windows very promptly take to burrowing This is well brought out in the case of *Quadrula heros* *Lampsilis ligamentinus* and others are very alert A similar reaction can be obtained at north windows But it is much slower and does not always occur The degree of turning is usually less, and the direction of movement less uniform

Light might be expected to affect the tonus of the siphons, thus determining the size of the apertures, and aiding in the regulation of the flow of water But such does not prove to be the case When other conditions are made as nearly equal as possible, it is found that a mussel maintains the same siphon aperture whether in direct sunlight, shadow, or darkness When carefully changed from one light intensity to another, or when masked and unmasked, there is a brief closure But the animal sooner or later becomes adjusted to the changed intensity and reopens the siphons to about the same extent as before

(3) *Phototropic Reactions in Nature* †

(a) Light *initiates* movement, (b) *orients* movement, and (c) rapid changes in light *affect the siphonal aperture* These conclusions have been derived experimentally, and under controlled conditions In the more complex life of a lake or stream the reactions are less easily predictable

A mussel in too shallow water is exposed to unusual illumination Light may be a constant stimulus to locomotion until deeper water is reached Thus the first conclusion is in harmony with the mussel's requirements in nature The trails of moving mussels show more or less trial and error in the finding of deeper water If light were the sole directive agency you might expect to find all the mussels of a level stretch of shallow bottom to be moving in the same direction That such is not the case is doubtless due to the other physical, chemical, and physiological conditions

It is improbable that light is the sole factor even in the rare cases where a well-defined light gradient exists Abrupt light gradients seldom occur except accompanied by sharp gradients in depth or turbidity In the former case pressure enters as an important factor Only in turbid water or in the presence of shadows is it likely that the conditions of the experiments are approximated closely enough to obtain pure phototropic reactions

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†The recent paper of Coker, Shira, Clark and Howard (1921) has come to hand just as the present manuscript is ready for publication Their observations have led them to the same conclusions as my own, except that they prefer to regard the depopulation of shaded areas as positive reactions to light of moderate intensity

The bivalve is vulnerable only where not covered by the shell It is particularly important to guard the siphons against invasion Hence their prompt closure even with the passing of a shadow No doubt enemies and large objects are excluded in this way The spurting of water is the means of driving away a persistent animal or bulky floating object

It is possible that the comparatively sparse population of *Potamogeton* beds is due to the checkered light on the bottom Of course the shadows of surface objects are much diffused at the bottom The *Potamogeton* bed is more difficult to traverse than open bottom or *Chara* Yet it is conceivable that the flickering light may keep a mussel more or less in motion until more evenly illuminated bottom is reached At any rate the interiors of many beds of plant are devoid of mussels, and the margins more populous than the interior An experiment (Allen, '21, 2) in which a lot of forty marked mussels all escaped after being planted in a *Potamogeton* bed at a depth of three and one-half feet, may be explained thus Several areas of Winona Lake have during recent years shown great increase in *Potamogeton* Invariably the number of mussels is correspondingly decreased Some beds are virtually abandoned

(d) *Hydrostatic Pressure*

Mussels were kept in aquaria and tubs in their normal posture upon sand, and otherwise behaving normally Then the water was gradually siphoned away so as to reduce its depth several inches Numerous individuals were incited to spurt water and burrow The reaction has been seen with such frequency wherever mussels are handled as to leave no doubt that there is a pressure sense, and that a mussel tends to seek its optimum depth—at least the depth to which it is temporarily adjusted

During the early summer of 1919 Winona Lake was deeper than in many previous summers—perhaps two feet higher than its observed previous minimum depth—due to rains and to the construction of a dam at its outlet The mussel population of its shallow wave-cut terrace was therefore subjected to an increase of pressure of from 10 to 100% Many of them had moved toward shore, as was evidenced by the long, zig-zag tracks, and the presence of the animals at the shoreward end Two weeks later the lake had gone down more than a foot

Many new tracks were then traced, and the makers found at the deeper end Evermann and Clark ('17) make brief reference to this behavior as of seasonal occurrence in Lake Maxinkuckee

The matter was checked up experimentally by planting mussels well inshore Those facing the lake sooner or later moved out Others facing the shore at first moved inward, but finally turned and went out

On the low gradients of the wave made terraces the above responses were slow, and often more or less random On the very level areas no preponderance of mussels pointing in either direction was discernible It was desirable to repeat upon a sharp gradient The sand bank of the Sugar Creek delta has such a gradient—about 30°, more or less Mussels were planted at a depth of two feet in normal posture, and faced both toward and away from shore The outcome was much the same as above, but the response took place within a few days There was much less random movement on the part of those facing shore, they turned very sharply toward deeper water, usually describing an arc of about a foot in radius to make the turn

This bit of shore is well exposed to wave action—the only other element except pressure or light which might have oriented the movements That it was not wave action is amply shown by many cases where the same reaction took place in sheltered coves Light is eliminated by the fact that in this case the siphons were oriented toward the meridian sun in the act of turning toward deep water, a result which is the exact reverse of that in Experiment 1 This and many other observations indicate that where light and pressure are opposed, the latter proves the more potent stimulus

The forty marked mussels mentioned in the above section may have been incited to movement by changes in depth

(e) *Equilibrium, Shell Weight, and Posture*

That bivalves possess an organ of the lithocyst type for maintaining an orientation with respect to gravity has long been known The stereotyped conception of this function represents the animal as lying on its side, putting its foot out laterally, securing a leverage on the substratum, and pulling itself erect This is accurate enough in the main, but does not take all cases into account The posture and manner of burrowing vary considerably Thus the organ of equilibrium serves to keep one species perpendicular, and another horizontal or oblique

The *Lampsilis* and *Unio* species usually have the erect position, while the *Quadrulæ* tend to lie prone (1) Variation in posture is closely associated with (2) shell weight, (3) with mobility, and (4) with metabolic activity At one extreme we have the very heavy shell of *Quadrula*, at the other the very light one of *Anodonta* *Quadrulæ* are extremely sedentary, *Anodontæ* active *Quadrulæ* nearly submerge themselves in the substratum, *Anodontæ* sit high in the water, the shell sinking only a little way *Anodonta* exposes its siphons boldly, is the most sensitive of all the Najades to stimulation upon siphon and mantle edge, and of all the Najades is the only one which exhibits a sensitiveness upon the entire mantle surface through the shell *Quadrula*, on the other hand, does not extend the siphons beyond the shell, does not have so well-developed siphonal papillæ, and reacts very slowly to stimuli *Anodonta* recovers from stimuli and resumes siphoning most promptly, while *Quadrula*, when caused to close the shell, may remain sealed up tightly for hours *Anodontæ* kept in aquaria, die most quickly of all mussels when conditions are not kept right In fact when miscellaneous mussels are kept indoors, even under the most favorable conditions possible, the *Quadrulæ* survive most of the others

The thin, translucent shell of *Anodonta* is accompanied by a more widely distributed light-sensitiveness Experiments such as the above show a certain avoidance of the light, but have a less marked orientation than *Q heros* The thick shell and well-shaded siphons of the latter admit light from virtually a single direction, making it perhaps the most favorable for such studies of light orientation

The above points of structure mark the *Anodonta* as a lake dweller, *par excellence*, and *Quadrula* as a river form *Unio* and *Lampsilis*, of more generalized type, are more readily adaptable to either situation Representatives of the several genera have taken on divergent habits, however *Q rubiginosa* inhabits lakes, and affects the upright position Yet it has a rather heavy shell and is quite sedentary When planted experimentally it does not move far In aquaria movements of the several species accord somewhat with the surroundings, and somewhat with the habits of the species

In moving water there may be less need for locomotion than in lakes, and less movement actually seems to take place The constant change of water is the equivalent of changing locality Isely's observations ('13) have shown that a mussel may remain upon the same spot for long periods of time, in streams

Deep burrowing forms are much commoner in streams The principal activity necessary to river species is to keep the siphons at the right distance from the substratum despite shifting bottom, etc *Plagiola elegans* submerges entirely beneath the surface of the sand Marine clams, Sphaeriidæ, etc, in like situation elongate the siphons to reach the surface of the substratum This species, like the ant lion, maintains a little crater whose center is at the siphons, and whose shape is dependent on the angle of rest of the sand Silt and rolling sand are kept out by spurts of water from the mantle chamber *Lampsilis anodontoides* is of a more generalized genus which has taken on a form comparable to *Anodonta*, except for its shell thickness This is considerable and marks the species a river mussel, as well as assigning to it the deep burrowing habit It also communicates with the water above through a crater-shaped pit The siphonal papillæ radiate out from the center and rest upon the floor of the crater In this position they perform their sensory functions and at the same time hold back the sand from the siphons With the shell thickness and burrowing habit of this species, as well as the *Quadrulæ*, may be associated the less delicate perception of stimuli *L anodontoides* accepts much more carmine into the mantle cavity than do other *Lampsiles* Burrowing species less promptly renew the crystalline style after starvation (Allen, '21, 1)

Résumé

The foot, mantle, and siphons bear tactile organs, whose abundance is in the reverse of the order named Their principal functions are the orientation of movements with respect to the substratum and avoidance of enemies Certain local reflexes exist which do not pass beyond the immediate stimulated region The innervation of each half of each siphon is independent, and from the splanchnic ganglion The ventral siphon is the more sensory, the dorsal is the motor termination of many reflexes which have their receptors in the ventral siphon (and in the osphradium) The dorsal has more to do with the regulation of water flow The papillæ of the siphon margin are the most highly sensory of all areas They are employed variously— in guarding the siphon, in gauging the depth while burrowing and in holding the sand back from the siphon

There is often an orientation in response to current that holds the bivalve to a definite course

The mantle, and especially the siphons are pigmented and light sensitive Experiments show clearly a negative phototropism in bright light, and an orientation of posture and movement with respect to light Low intensities of light may incite movement without orienting it The reaction to moving shadows is obviously one of avoidance of enemies and debris

The magnitude of reactions is dependent in part upon temperature and oxygen Light does not determine the permanent aperture of the siphons

A sense of pressure exists by which the optimum depth adjustment is made When conflicting with other senses, that of pressure is shown to predominate Reactions to gravity vary in the species in harmony with the posture habits

4 CHEMICAL STIMULI

Experiments were made to ascertain the reactions to varying strengths of several acids and bases No attempt to determine the differential effects of the respective reagents was made, but only the types of reaction and location of the receptors

The reagents were brought into contact with the epithelia through a finely drawn pipette The latter was manipulated very cautiously so as to eliminate possible mechanical stimuli through pipette or solution The mantle edge and both siphons were tested, other epithelia by causing the reagents to enter with the incurrent water by carefully introducing the pipette through the center of the siphon far enough to prevent contact with the siphons themselves

The best series of reactions was obtained by the use of acetic acid, ammonium hydroxide, carmine, and foul water from decaying Spirogyra, and hay infusions

Drops of 1 0% acetic acid were applied at several points on the outside of the respective siphons and mantle edge beneath the siphons In all cases there was a rapid closing of both siphons and a rapid and violent discharge of water

When siphoning was begun again, the point which had been touched with acid was found to be drawn back sharply—even sometimes the entire half siphon, and this effect was perceptible after several hours

If while still under this initial stimulus 0 1% to 1 0% acid was administered, the animal still responded, but much less promptly The effect of the 0 1% acid was of much less duration, but at first of equal magnitude

Very few animals gave any response to the acid of 0 01% more or less, when applied to either mantle or siphons

By the use of ammonium hydroxide a similar scale of responses was obtained, 0 5% evoked a very rapid and profound response—even in mussels that had been very inactive The effect passed much more rapidly than in the case of the 1 0% acid 0 1% ammonium hydroxide had a great effect upon the same individuals just recovering from the stronger alkali, but more effect on fresh animals 0 01% obtained a very slight and tardy response When given in water of low temperature—12° to 14° C —0 01% gave no reaction whatever

From the above it is clear that the mantle edge and siphons are provided with organs of chemical sense, which are keenly sensitive to acid and alkaline substances of high concentration The response was equal in the case of the ventral siphon and of the subjacent mantle edge, but noticeably less in the dorsal siphon

Carmine and foul water elicit no reaction from siphons or mantle edge, as was true of all very low concentrations

The osphradium has been known as an organ of chemical sense, largely from its structure Before water may be tested chemically it must first pass through the ventral siphon, the mantle chamber, the gill chambers, and the suprabranchial chamber At first thought the position of the osphradium under the visceral ganglion seems remote and futile, since the character of the water may not be known until just before leaving the animal Conversely it may be of some advantage to have all the water pass a common point such as this However it is probable that the osphradium is phylogenetically a more ancient structure than the siphons, and long associated with the visceral ganglion—hence its position there rather than upon the neogenetic mantle structures The mussels of lake or stream seldom encounter solutions of great concentration

When dilute, their diffusion is sufficient to cause a closure of the shell before much harmful matter can enter

The following tests of the osphradium were made to determine whether it possesses chemo-receptors, and if so their relative sensitiveness, compared with those of the mantle and siphons

The finest carmine, pipetted from the upper levels of a carmine suspension which had settled for several days, was introduced into the ventral siphon There was no response from the siphons Just before the carmine could be seen to have reached the dorsal siphon, there occurred a quick closure of the ventral siphon, followed by that of the dorsal, and a prompt reopening of both Thus it is seen that the carmine had not affected any sense organs until it had nearly reached the dorsal siphon—the location of the osphradium

Stale water and infusions were never found to affect the chemo-receptors of the siphon and brought about no reaction until they reached the osphradium

There was still the slight possibility that the gills or mantle might possess organs of chemical sense Therefore to produce a more marked effect upon the osphradium alone than is possible by introducing reagents into the siphon with respiratory water, the following experiment was tried

A few drops of 1 0% to 10 0% acetic acid were drawn into a fine pipette, the latter inserted into the dorsal siphon just far enough to reach the osphradium, the acid discharged and instantly drawn back again into the pipette with considerable water from the suprabranchial chamber Thus it was made sure that the concentrated acid affected the osphradium region only, and that only very dilute acid if any reached the dorsal siphon The following results were noted

(1) Neither siphon fully opened within a week or more, though the water was purposely allowed to grow stale sometimes

(2) The papillæ of both siphons remained in contraction

(3) Vigorous burrowing, and frequent spurting

(4) Both siphons still very sensitive to dilute acid

(5) The osphradium was still sensitive to dilute solutions, not all its receptors had been destroyed or paralyzed

Another test consisted in isolating the osphradium from the outgoing current This was accomplished by lowering the water level to a point just sufficient to flood the floor of the suprabranchial, and so as to leave the osphradium above the surface As soon as the animal had ceased spurting and grown accustomed to the water level, and accustomed to having the posterior end out of water, the fine carmine suspension previously mentioned was introduced into the still submerged ventral siphon

A stream of carmine could thus be kept passing through a mussel for an indefinite length of time The siphons were not adjusted to register so nearly neutral a reagent When the water level was raised again slightly and the osphradium flooded the usual response to carmine again took place

These reactions verify the usual conception of the function of the osphradium, and show something of its range

5 TONUS OF THE SIPHONS

It has been seen that mechanical stimulation and light exert no permanent influence upon the muscle tonus of the siphons and regulation of the streaming Chemical stimuli do have this function Mussels placed in water containing little oxygen maintain always a much wider aperture As noted previously this is the more pronounced in the case of the dorsal siphon

When the water is greatly fouled by material in decay, the siphons (especially the dorsal) more or less completely close Entire closure may result in such inactive mussels as *Quadrula heros*, but rarely so in the more active *Anodontæ* or *Lampsiles*

6 ACCESSORY SIPHONS

When under conditions of deficient oxygen not only do the siphons widen to their greatest extent to bring in more water, but also additional spaces between the mantle edges are thrown open In most species there occurs a very definite accessory dorsal siphon, the *supra-anals* of Ortmann ('12) above the dorsal It is not provided with papillæ, and is not so sensitive to the various stimuli enumerated above It is only opened in emergencies, uncommonly under normal conditions In the several species the supra-anal varies in its length, and in its distance from the dorsal siphon Likewise there is a variation in the extent of the cloaca above the suprabranchial channel It reaches its maximum dimensions in

Quadrula heros or *Lampsilis alatus*, whose mantle extends dorsad to the full extent of the *ala* The ciliary movement of the cloacal portion of the mantle is ventrad and centers at the dorsal siphon—not the supra-anal The higher the shell and mantle extend above the siphons, the longer is the accessory siphon of the several species

Ventral to the incurrent siphon other temporary openings may appear between the mantle edges Rarely (in extreme exhaustion) this opening extends the full length of the mantle When the siphons have been injured or over-stimulated, and when they lie above the surface of the water, the mantle is allowed to stand open along its ventral margin

Résumé

It was shown by experiment that the siphons and mantle margin are subject to chemical stimulation only of considerable concentration Lower concentrations take effect through the more sensitive osphradium Since high concentrations do not ordinarily concern the animal in its normal habitat, the chief sensory functions of the siphon are those of physical character By means of the osphradium the mussel reacts to very small changes in the chemical nature of the water The muscular tonus of the siphon and mantle is under control of the chemo-receptors of the osphradium Through the resulting apertures of the siphons, and occasional accessory openings of the mantle, the regulation of water flow is accomplished Normally the ventral siphon has a more constant aperture, while the streaming is controlled by the anal

7 CONCLUDING REMARKS ON THE NERVOUS SYSTEM

The siphons, due to their exposure, and to the intake of water, have attracted a large share of mantle musculature, and with it the richest share of motor and sensory nerve endings These center at the splanchnic or visceral ganglion So far as the "conscious life" of the mussel has come to center about the siphons and osphradium, the visceral ganglion is physiologically the brain In the sense that cephalization is usually accompanied by corresponding development of a cephalic ganglion and cephalic sense organs, the visceral ganglion has largely taken over these functions in the mussel which communicates with the outside through posterior siphons To be sure the cephalic ganglion still retains two pairs of commissures in communication with the other ganglia, but its sensory functions are of a less peripheral character than those of the visceral

By virtue of homology and position at the anterior extremity of the body the cephalic ganglia are entitled to their name They possess little analogy to a true cephalic organ

That the mantle and visceral innervation of the mussel is divided about equally between the cerebral and visceral ganglia, and that the two ends of the animal are rather independent of each other, is shown by the following experiment

The two valves were wedged one-fourth inch apart by a fulcrum of wood at the center of the ventral margin The point was selected where the pull of the two adductors just balanced each other Then the two ends of the mantle and visceral mass were prodded by turns By turns there was a greater adduction at the stimulated end This was sufficient to overcome the already vigorous contraction of the other adductor, and caused the relaxing end to gape more widely Additional stimulus at either end overcame the balance The magnitude of the response decreased progressively as the stimulus was applied nearer and nearer the block, where the branches of the pallial nerves overlap and anastomose The narrowness of the mollusk's existence is much expatiated upon The principal reactions of the bivalve when summed up include only Protraction and retraction of the foot, adduction of the shell, protraction and retraction of the mantle margin and siphons The movements of locomotion and burrowing respiration, waste disposal, and driving away of intruders are chiefly made up of combinations of these five reactions, supplemented by ciliary activity It is as though the whole existence of a mammal were made up of stretching, yawning, and sneezing Usually more than one of these reactions follows a considerable stimulus After many observations one can become more or less skilled in predicting from the manner of a movement just what will follow it For instance, in the way of closing the shell one can foretell that burrowing will ensue When the siphons are opened in a less cautious way, one may predict that the animal is about to "sneeze"—i e , spurt water through the siphonal region

In many of the activities of the mussel cumulative movements are seen The initial stimulus is insufficient to incite the entire series of movements directly Only a small portion of the foot or siphon may be set in motion at first, then in wave-like fashion the contraction passes on and engages all parts of the organ Local reflexes are probably responsible for this behavior, for it is observable even in a foot or siphon which is dissected out and not in communication with the central nervous system The contraction of one region stimulates the adjacent areas, and they in turn by contracting pass the movement onward

Three elements at least have contributed to the degenerate character of the bivalve nervous system

(1) The aquatic life, comparative uniformity of the physical and chemical environment New and difficult conditions have not often confronted them The advent of the industrial period, and stream pollution have found them unprepared except as to great fecundity

(2) The nearly sedentary life, passive feeding habits, and slight need of locomotion

(3) The sheltered existence within the shell, and passive immunity from attack by enemies

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MINERALIZATION ALONG THE DIKES OF SOUTHERN VERMONT *

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INTRODUCTION

The region covered by this study lies in southern Vermont about fifteen miles north of the Massachusetts boundary line Wilmington, latitude 42° 52′ N, longitude 72° 52′ W, in Windham country, was about the center of the field of operation Most of the work done was between the parallels of 42° 45′ and 43° N and the meridians of 72° 45′ and 73° W The majority of the work was done in the township of Wilmington, although adjoining townships were partially covered

The country rock of this region is predominantly a quartz-mica schist which varies greatly both in structure and composition As regards structure, it is found with both slaty and gneissic forms, although it is typically an ordinary schist It is much folded into anticlines and synclines, some of which have an axial length of several miles, and it also has profound local contortion and severe crumpling In composition the range is from almost pure quartz to almost pure mica, with fifty per cent of each as the typical combination The mica is generally biotite, but it is sometimes accompanied by muscovite, paragonite, and in rare cases, phlogopite The quartz is almost always colorless or milky, but it is occasionally pink, due to the coloring properties of some compound of iron in minute quantities The range of composition is further varied by the addition of accessory minerals, the most common of which are feldspar, magnetite, pyrite, and limonite pseudomorphs after pyrite

The whole region is shot full of semimetamorphosed dikes of diorite and of later quartz or quartz-feldspar dikes, which often cut through the diorite dikes and seem to pay even less attention than they do to the structure of the country rock and its planes of schistosity The outcrops of the dikes vary in width from a few hundred yards to two or three miles The quartz dikes vary in size within wider limits than do the diorite and send out stringers into the country rock much more extensively Although nothing is known of the mass or masses of magma in which these dikes originated, it is extremely probable that they came from the same magmatic basin and that they form a series of complementary dikes which, if mixed in amounts proportional to the quantity in which they occur, would give the chemical and general mineral composition of the original large mass Thus the variation in composition of the dikes is assumed to be due to variation in composition of the magma or sub-magma at different periods

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DESCRIPTION OF DIKES

The typical composition of the diorite is one of nearly 70% of hornblende, about 30% of feldspar with quartz in varying quantities, and some iron-bearing mineral, either pyrite or magnetite, in slight amounts The range of composition is from an eighty-twenty relation of the essential minerals to one of fifty-fifty, innumerable variations occurring between the two The rock is generally very fine-grained, with the feldspar and quartz arranged in spheres or circles scattered evenly throughout the rock At times the feldspar and quartz bunches are so fine that they are discernible only under the microscope In rare cases the centers of these quartz or feldspar spheres are hollow, but generally they contain biotite, magnetite, pyrite, limonite pseudomorphs after pyrite, or very good hornblende crystals In a case where biotite occurred in the center of the quartz spheres, a microscopic study of the specimen showed a zonal arrangement of the two minerals The outer shell of the sphere consisted of quartz with only microscopic crystals of biotite, the next had quartz and biotite in about equal amounts, evenly intermingled, and the center consisted of almost pure biotite A careful microscopic study of other minerals found in the center of feldspar and quartz bunches would probably show a tendency toward the same sort of zonal arrangement The same minerals which occur in the centers of the feldspar circles generally occur scattered throughout the diorite itself in minute ill-formed crystals Only in one or two cases did the biotite occur with sharply defined crystal angles or the magnetite with perfectly triangular octahedral faces

The acidic dikes and stringers are usually nearly pure milky quartz Quite often they are of quartz and feldspar in varying proportions, and the feldspar occurs in various-sized blotches surrounded by quartz, into which feldspar stringers sometimes extend This silicate may be light-gray oligoclase or white albite, but is generally a pink feldspar which has been proved by the petrographic microscope, in all cases studied, to be pink microcline This bears out Pirrson's theory that the potassic feldspars are pink due to finely disseminated iron oxides because potash does not readily enter into combination with iron In connection with the results of mineralization found here, it may be interesting to note that he believes the gray color of oligoclase to be due to finely divided ilmenite disseminated through it Sometimes there is more feldspar than quartz in these dikes, and in one or two places small irregular stringers of practically pure feldspar were found

MINERALIZATION

The mineralization along these dikes is extensive, as might be expected, but the quartz and quartz-feldspar dikes have a much greater amount of it because the most active volatile constituents of a magma, such as Ti, Cl, Fl, B, and the hydroxyl and sulphate radicals, seem to accompany the acidic rather than the basic sub-magmas

Practically the only minerals found in and near the diorite dikes as the result of mineralization are pyrite and magnetite, although some of the unusually large and well-formed biotite crystals which are found in places in the diorite may have been influenced to some extent by mineralizers The magnetite is usually disseminated through the dike itself in small indistinct crystals of microscopic size though sometimes it occurs in aggregates of these crystals, and occasionally in single good-sized perfect octahedrons In the country rock, the magnetite crystals are generally fewer in number, but better developed The pyrite is almost always in single well-formed cubes of various sizes, both in the dike and in the country rock, but it is much more apt to be concentrated along the contact than the magnetite, and frequently occurs in aggregates of crystals there Occasionally a large pyrite crystal is found including a smaller one of magnetite Very often the pyrite is completely altered to limonite pseudomorphs before any other sort of weathering is apparent

Occasionally inclusions of the schist in the diorite dikes and portions of the schist close to the contact contain good crystals of hornblende and feldspar The presence of these minerals in the dikes is not due to mineralization, but their occurrence in the country rock is undoubtedly due to it A further evidence of mineralization along these dikes is in the finding of rare crystals of paragonite and phlogopite, always found close to the contact in the country rock

Mineralizing gases may by their presence influence crystallization or recrystallization without entering into direct combination; and it is possible, if not probable, that much of the fine crystallization of minerals within the feldspar spheres of the dikes is the result of this influence

It is along the quartz and quartz-feldspar dikes, however, that the best and most abundant evidences of mineralization may be found The range of minerals occurring along this class of dikes is much greater than that of the diorite dikes It includes biotite, muscovite, the hydrous green micas, ilmenite, magnetite, pyrite, tourmaline, actinolite, epidote, hornblende, and others The mineralization which results in some form of mica is by far the most common, and of these micas, the most common form is biotite It occurs in good crystals along the contacts and extends into the dikes and country rock either side of the contacts In the dikes, the crystals are conspicuous by reason of the contrast in color, but in the country rock they merely make the schist look darker and denser near the dike, due to this increase in the amount of biotite In one exceptional case some beautiful large crystals were found in the very center of a quartz dike This phenomenon was probably caused by the rapid cooling of the quartz which left cavities where the biotite crystals were formed and were later surrounded by an inflow of quartz in heated aqueous solution

Muscovite, for some reason, is very rare In a few cases, it occurs in small flakes with some other true mica, and in only one case it is known to occur in beautiful large and distinct crystals in a quartz dike Phlogopite is as rare here as in the diorite dikes, but paragonite is more common and occurs with muscovite in several places in the schist, near contacts with the dikes It also occurs in bunches of fine crystals in the quartz of the dike itself, and in one such occurrence where the crystals are strung out along the contact between the quartz and the feldspar, it is noticeable that the contact between the quartz and the mica is much sharper than that between the mica and the feldspar In fact, inclusions of crystals of the mica in the feldspar and the reverse are common, while such a thing is almost never observed in the quartz

The hydrous green micas are widely found in the schists Penninite occurs with a pearly lustre and appearance so closely approximating that of biotite that a hasty examination does not disclose the difference Chlorite is often found and comes both from hornblende and from biotite, as evidenced by its general form and its associations

Tourmaline is found almost everywhere along the dikes It generally occurs in small distinct needles disseminated in the country rock near the dikes, but occasionally it occurs in single crystals and in aggregates of crystals whose dark color is sharply contrasted with the white of the quartz matrix Epidote is not very common and generally occurs in rather a massive form between the country rock and the dike Large masses of beautifully crystallized actinolite, associated with quartz, are found in such quantity that it must be assumed here, as perhaps for the epidote above, that the largest part of the basic material for the mineral was already present in the country rock and that the mineralizers merely changed its form or perhaps added to it other elements in slight amount

Ilmenite occurs in medium amounts, almost always within the edges of the quartz dikes themselves, sometimes along the contact, and rarely within the country rock It is not usually in good crystals, but occurs in plates as much as two inches long Magnetite is much more common than the ilmenite As is the case near the diorite dikes, the magnetite is apt to be disseminated through the country rock near the contact in small, imperfect crystals It also occurs in the quartz-feldspar dikes themselves in good crystals, as well as in aggregates Pyrite is also very common and has much the same sort of occurrence as does magnetite It is apt to be better crystallized though, especially in the dikes In one case it occurs in especially large good crystals scattered through a quartz dike, and the crystals are twinned and ribbed in a peculiar manner

In several cases it is noticeable that in a quartz-feldspar dike, the contact between the feldspar and the country rock is much less sharp than between the quartz and the country rock

An analagous difference in type of contact between these two minerals and crystals of mineralization has also been noted, and in one or two cases a pure quartz dike is accompanied by almost no effects of mineralization whatever It may be that some part of the feldspar acts as a mineralizer itself or that the feldspar as a whole is simply more active when crystallizing than the quartz is It would take a much more detailed study than this to arrive at any conclusion which could be put forth with any assurance as to its correctness

SUMMARY AND CONCLUSIONS

To recapitulate the two types of complementary dikes found in this region in southern Vermont, of diorite and quartz and quartz-feldspar, are accompanied by extensive mineralization The type of alteration found in the country rock near the contacts is much the same in many respects for both kinds of dike The quartz and quartz-feldspar dikes, however, have much the longer list of minerals resulting from mineralization since the more volatile constituents of a magma seem to accompany the acidic rather than the basic sub-magmas The common minerals thus formed are hornblende, actinolite, tourmaline, biotite, muscovite, phlogopite, paragonite, pyrite, magnetite, ilmenite, and others

There is much undoubted mineralization which, so far as we can see, is associated with no dike at all, but which should serve as a guide for further search for dikes

The descriptions here given and the problems stated are the result of a preliminary and somewhat superficial study of a region almost wholly unknown geologically except in a very general way It is evident, however, that the region is a very interesting one and offers an excellent field for the study of the results of metamorphism The work as yet has been barely started, and it is hoped that further careful study by those interested may solve the problems mentioned and many others unmentioned, but undoubtedly present

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A CORN-FEEDING GEOMETRID

Pleuroprucha insulsaria Guen (Lep Geometridæ)

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INTRODUCTION

In his monograph of the corn-feeding insects (3, p 173) Forbes remarks on the fact that not a single species of the Geometridæ has been reported as feeding on this plant except an undetermined species mentioned many years ago by Smith (6, p 188) So far as the writer has found no such report has been made since that time For several years past, however, various observations have been made on a small geometrid larva occurring in varying abundance from year to year on corn silks This species, *Pleuroprucha* (*Deptalia*) *insulsaria* Guenee appears never to have received the attention of economic entomologists The injury it causes is trifling, but as a corn-feeding insect it is worthy of record

The larvæ were first found in small numbers but well distributed in corn fields in the bottom lands along the Cumberland and Tennessee Rivers in eastern Tennessee, in August and September, 1913 They were again noted at Nashville, Tennessee, the following year At Knoxville in 1916, and more especially in 1917, they were so abundant that an excellent opportunity was afforded to study their habits The data contained in the following article were obtained for the most part at Knoxville in 1917 Full credit and grateful acknowledgement are given to Mr W B Cartwright, my assistant at that time, for his interested co-operation and assistance and also to Dr Dyar, of the National Museum, for his kindness in supplying me with many of the distribution records quoted below and with a copy of Packard's description of the adult moth

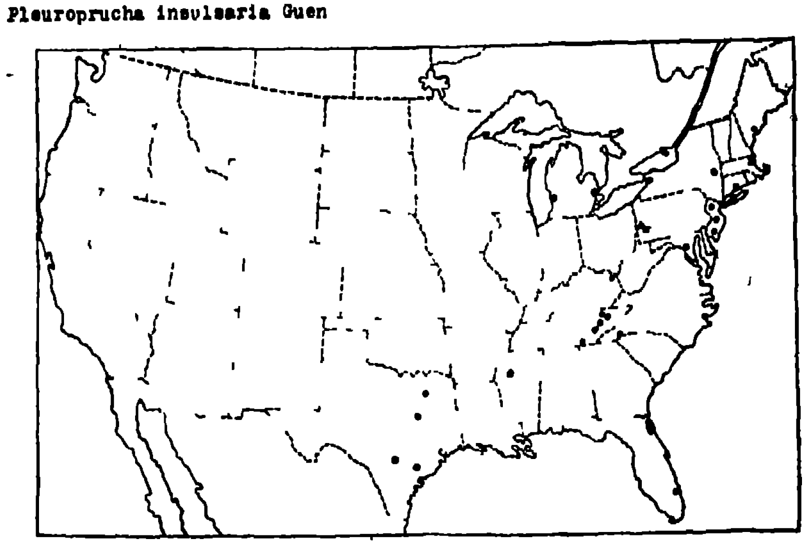

Fig 1 Known distribution of *Pleuroprucha insulsaria* Guen in the United States

DISTRIBUTION

The writer has taken larvæ of *Pleuroprucha insulsaria* at numerous points in eastern Tennessee and Kentucky and as far west as Nashville, Tenn There is a note in the Bureau files recording the collection of larvæ on corn silk at Greenwood, Miss The species is included in Britton's (1, p 120) check-list of the insects of Connecticut Smith (7, p 498) lists it as "common throughout the State" of New Jersey In his catalog Dr Dyar gives the distribution as "Atlantic States" and in a recent letter he informs me that he has records from

Texas, North Carolina, District of Columbia, Florida, Pennsylvania, New York and Michigan He has also given me the known distribution outside the United States, which shows it to occur in Mexico and Central America south to the Canal Zone, and throughout the West Indies Walker (8, p 737) also described the same species under other names from Venezuela, Florida and Jamaica In addition to the states mentioned above Packard (5, p 335) records it from Maine and Massachusetts The exact localities when known are indicated on the accompanying map

FOOD PLANTS

Fresh corn silk seems, without doubt, to be the favorite food of the larvæ Thorough search has repeatedly been made of other vegetation, especially of plants with flowers, to find whether any succulent floral tissue would serve as food In only a few instances have the larvæ been found in such locations and then usually after fresh corn silk had largely disappeared from the fields On August 31, and again on September 18, three larvæ were found on flowers of a cultivated species of *Helianthus* on which evidently they had been feeding Other larvæ were swept September 6 from smartweed (*Polygonum pennsylvanicum*) in bloom and again on September 25 six larvæ were swept from flowers of *Verbesina occidentalis* A single larva was swept from a mixed growth of oxeye daisy (*Chrysanthemum chrysanthemum*) and daisy fleabane (*Erigeron philadelphicus*) on June 12 Two larvæ were also found on flower heads of sumac (*Rhus glabra*) on August 21, and when confined in boxes with this same food they fed by eating small notches in the tender flower stalks Most of these collected larvæ were reared to maturity so their identity cannot be questioned Other larvæ quite similar in general appearance were also collected on various flowers, but when reared proved to be other species Those taken on corn silk were all of this species

In addition to the food plants observed in the field some cage experiments were conducted Larvæ were reared nearly to maturity on caged flower sprigs of *Erigeron philadelphicus*, but because of neglect failed finally to pupate In this case the rays were eaten and possibly the disk flowers to a slight extent Larvæ confined in a box with fresh flowers of red clover (*Trifolium pratense*), horse nettle (*Solanum rostratum*), daisy fleabane (*Erigeron philadelphicus*) and strands of fresh corn silk fed only on the corn silk In another experiment larvæ were confined individually in tin boxes and given flowers or flower clusters of alfalfa, pigweed (*Amaranthus retroflexus*), cowpea, mullein (*Verbascum thapsus*), ragweed (*Ambrosia artemesiaefolia*) and smartweed (*Polygonum pennsylvanicum*) and with leaves of bluegrass (*Poa pratensis*), corn, cowpea, mullein, crabgrass and with anther sacks and pollen of corn, but only those supplied with the corn pollen and the smartweed flowers fed and matured, showing quite conclusively that, although not strictly limited in food habits, the species is far from a cosmopolitan feeder

Packard (5, p 335) states that he has reared the larvæ on *Celastrus scandens* and Smith (7, p 498) in addition lists *Galium*, *Cassia* and oak as food plants, but does not specify what parts of these plants are eaten Dr Dyar writes me that he has found a pupa on alder and that in one instance the larva occurred abundantly on golden rod (*Solidago*) brought into the house for decorative purposes

SYSTEMATIC HISTORY

The following names and references, kindly supplied by Dr Dyar, give in brief outline the systematic changes through which this species has gone

Acidalia insulsaria Guenee Spec Gen, 9 169 1857 N A
Acidalia asthenaria Walker C B M 22 737 1861 Venezeula
Acidalia nivariata Walker, C B M 25 1500 1862 East Florida
Acidalia imparata Walker, C B M, 25 1508 1862 Jamaica
Acidalia persimilata Grote Proc Ent Soc Phil, 1 347 1863
Acidalia insulsaria Packard, Mon Geom Moths 335 1876
Deptalia insulsaria Hulst Trans Am Ent Soc, 23 300 1896
Deptalia insulsaria Hulst Bul 52, U S N M, No 3477 1903
Pleuroprucha insulsaria Barnes & McDunnough List No 3014 1917

SEASONAL HISTORY

Smith (7, p 498) reports the moths as occurring in New Jersey from June to October The earliest record we have for Tennessee is May 31, when several of the moths appeared at light During the summer of 1917 frequent collections were made at light from June 25 to September 26 and the following data on the occurrence and relative abundance of the moths were obtained

Occurrence and Relative Abundance

DATE	♂	♀	TOTAL	DATE	♂	♀	TOTAL
June 27	1	1	2	July 28	0	21	21
" 29	0	1	1	" 30	0	3	3
July 4	1	1	2	Aug 3	0	2	2
" 8	9	6	15	" 4	2	5	7
" 9	0	2	2	" 6	1	2	3
" 10	3	4	7	" 11	1	0	1
" 11	18	26	44	" 13	2	23	25
" 17	32	118	150	" 14	5	36	41
" 19	0	2	2	" 15	1	5	6
" 21	30	505	535	" 20	2	4	6
" 23	5	27	32	" 25	1	0	1
" 26	4	18	22	Sept 2	3	8	11
" 27	0	3	3	" 5	1	1	2
				" 10	1	0	1

Several of the moths matured in rearing cages between October 6 and 19 and one female moth was taken in the field October 15 The table shows the emergence of two generations of moths, one reaching its maximum about July 21 and the other August 14 There are undoubtedly other generations both before and after these So much for the moth records

The earliest larval record is that of one swept from blooming daisies June 12 Larvæ were first found abundant on corn silk July 31, but judging from the moth record they must have occurred much earlier and in great numbers either on corn silk or some other food plant They remained abundant on corn silk the first half of August and scatteringly until September 10 After August 15 the corn silk had mostly dried and larvæ very quickly became scarce Occasional individuals were taken on smartweed and other plants until September 25, which is the last date we have for the larvæ

Just how this species passes the winter is still an open question That either the egg or the pupa stage can be so greatly prolonged seems impossible The adults are never seen during the winter, as they surely would be if they survived, so the larvæ must pass the winter either fully or partly grown Further observations are needed to subtantiate this theory

To summarize, the seasonal history, as far as facts are available, seems to be as follows In the spring the few individuals surviving the winter become active The larvæ lead a precarious existence, feeding on flower tissue of various plants practically in the open and exposed to the attacks of birds and predaceous and parasitic insects Until corn silk becomes available the species does little more than maintain itself With the widespread appearance of fresh corn silk which furnishes at once not only an abundant and suitable food supply, but shelter and protection from enemies as well, the insect is enabled to increase to enormous numbers almost in a generation The silk persists long enough for two generations to develop With its disappearance the former hazardous conditions again prevail and the species is quickly reduced to negligible numbers That the same degree of abundance is not reached every summer may be due to unfavorable winter conditions cutting the number of survivors almost to the point of extermination or to the presence of other and more effective parasites than the *Apanteles* noted below

THE MOTH

Description A delicate luteous species with very triangular wings, especially the hind wings which are short and on the outer margin much less convex than usual Antennæ and space between silvery-white, in the male pectinated on basal half, front of a peculiar greenish tawny hue, palpi pale, slender, upcurved and passing beyond the front Both wings alike, luteous with an almost imperceptible greenish tinge, flecked irregularly with darker scales, without any distinct lines, except an obscure, fine, white, waved, submarginal line dotted with black on the venules, discal dot represented by raised scales, edge of both wings dark (?), slightly scalloped, fringe very long, slender, a little unequal, beneath paler, with marginal and submarginal rows of rufous venular points Length of body, ♂ 7 5 mm ♀ 7 0 mm , of fore wing ♂ 10 5 mm , ♀ 9 5 mm , expanse of wings, 18 75 to 21 25 mm (Revised from Packard)

HABITS OF THE MOTHS

The moth is nocturnal in habit and spends the day hidden under some leaf, flying only if disturbed At rest its wings are always outspread and closely flattened to the surface The sexes are easily distinguished by the antennæ, filiform in the female and in the male pectinate from the base for about half their length, the first 15 segments each bearing two unequal finger-like processes There are several other moths closely resembling this species in size and coloration, but this is the only North American representative of its genus

The moths come very freely to light but after reaching it do not flutter about but rest quietly nearby with wings flatly outspread Among those taken at light the females greatly predominate Of 200 taken at random on July 21, 1917, 91% were females Of a total of 958 coming to light of which record was made 834, or 87%, were females This abnormal ratio is very likely due to the fact that most of the collecting was done before midnight while experience with other species has shown that the males come in much greater numbers after that time This supposition is further borne out by the fact that among the moths reared, the sexes were very evenly divided Nearly all the females coming to light were gravid Only one pair was observed in copulation and they were apparently abnormal for they died still in copula Practically all the eggs obtained in cages from collected moths proved fertile

The moths are short-lived In cages where the conditions were made as normal as possible, the average length of life for 44 moths was 6 4 days with a maximum of 13 The sexes were about equal in longevity

THE EGG

Description Length 512 mm , width 318 mm Evenly ellipsoidal except for a slight flattening in one plane, parallel with the long axis, and attached by one of these flattened sides Chorion shining, evenly and coarsely reticulated over the entire surface, there being 12 to 15 of the spaces in the length of the egg

NOTES ON THE EGG

When first laid the eggs are pure white, slightly watery In a few hours they become pale yellow, by the second day mottled, and the embryo can be discerned doubled in the egg in the form of a horseshoe Early the third day the group of red ocelli can be seen as dark specks near one end and later in the day the dusky striping of the larva shows plainly, giving the egg a dingy cast The larva emerges in 2½ to 3 1-3 days from the time of oviposition, through a hole near one end of the egg, at the point occupied by the head of the embryo larva The empty shells are iridescent, colorless, and usually retain their shape

The number of eggs laid by individual moths varied greatly Many laid none For the 60 moths of which record was made the average was 24 eggs The largest number produced by one moth was 138 and her ovaries still contained eight fully developed eggs when she died Another laid 125 It seems likely that the number normally produced by a moth in nature is not far from 100, more rather than less Dissections showed the ovarioles full of egg cells in various stages of maturity

Moths confined in cages readily laid eggs The cage used consisted of a lantern globe with a cloth top set on a disk of blotting paper resting on damp sand and contained a tube vial filled with water and plugged with a wad of cotton in which a small lock of corn silk was wedged Eggs were laid on all parts of the cage and its furniture Over 1400 eggs were laid by moths in the various cages, placed as follows On the corn silk 55%, glass of globe or vial 32%, blotting paper floor 8%, cotton plug 3%, cloth top 2% In the field eggs have been found only on corn silk or on the husks near the tip, close to the silk

The eggs laid on glass were so firmly fastened as to be difficult of removal without injury, but those on the cloth, paper or corn silk were easily detached with brush or needle

THE LARVA

Description Newly hatched larva Length, extended, 1 632 mm, head width 194 mm, body width 141 mm Head rather broad, whitish, with acute hairs on face, three of the ocelli red, the other three pale Thorax as broad as head cephalad, narrowing caudad, pale yellow Abdomen slender, the segments as long as broad except the last three shorter and the last one much broader with two pairs of prolegs on the sixth and last segments respectively, the crochets brown Abdomen very pale yellow laterally slightly dingy above and below, the dorsal dingy area margined on each side by a narrow brown stripe which becomes obsolete on the thorax and on the last abdominal segment which is paler than the rest of the body The thorax and abdomen bear short capitate hairs laterad The larva is a pronounced looper throughout its entire life

A lot of larvæ taken from corn silk were measured and easily sorted into five instars whose head measurements are tabulated below

	HEAD WIDTH		
INSTAR	MAXIMUM	MINIMUM	AVERAGE
I	194	194	194
II	300	282	291
III	477	441	450
IV	688	600	644
V	1 024	918	971

The fourth instar larva was described as follows Length 11 mm Entire body, including head longitudinally striped with narrow nearly continuous more or less broken stripes of brown yellow gray and pink, more or less mixed with whitish, the dorsum darker than the spiracular stripe which usually contains considerable white Ventral surface like the rest with the median stripe paler except the surface between the prolegs pale and unmarked Head striped like body, but paler about mouth parts pale ventrad Tubercles on dorsum small, black, those on the side pale, all with short black setæ Prolegs on sixth and ultimate segments with a single row of large crochets on inner margin

HABITS OF THE LARVÆ

The larvæ are inconspicuous on the locks of corn silk and ssem to be colored to match their habitat They vary from pale yellow and green through orange, red and brown to jet black, the ventral surface usually paler In some the color is almost solid, in others transversely banded with darker and paler shades giving the larva a knotted or mottled appearance which is especially effective protection when at rest on the disk of a composite such as a sunflower Their colors match perfectly with the varying shades of color of the maturing corn silks The larvæ are so slender, especially in the early instars that they are not readily distinguished from the strands of silk and, except for the fact that they are so active, would be hard to find When a lock of silk is disturbed the larvæ, especially the larger ones, which may happen to be on the outside and not entangled in the silk, drop instantly as if falling, but almost invariably suspend themselves by a strand of silk Occasionally one falls free but generally lodges on a leaf below They usually drop about three or four inches but sometimes as little as half an inch and in one instance a larva was observed to drop four feet and hang suspended only a few inches above the ground After dropping they hang perfectly straight and motionless for a few seconds and then by a twisting, squirming motion of the head and thorax, using the thoracic legs to wind up the silk, draw themselves back to their former location The larger larvæ are extremely nervous and will jump and throw themselves violently about at the least irritation If a lock of silk be lifted and spread out a little and held quietly for a few seconds the younger larvæ and those entangled in the silk become active, holding fast by the abdominal legs and waving the anterior part of the body in the air or remaining in a humped position This activity reveals their presence

During periods of greatest abundance often every lock of silk not entirely dry is infested As many as 13 larvæ have been found in a single lock and averages of four or five are common The number of larvæ is often incommensurate with the great abundance of the moths, and cannabalism may account, in part, for this Larvæ confined in boxes often cripple one another and in one instance a larva was found in the field in the act of consuming a smaller neighbor

As long as the silk is fresh, larvæ move about from ear to ear to only a slight extent but toward the close of the season when the silks are dry they are frequently found on other parts of the plant searching for food They have several times been found in the leaf axils feeding on the corn pollen accumulated there When silk becomes scarce they often congregate on the few late ears and keep the silk cut off close to the tip of the shuck In a cage confined to an ear with drying silk, they push down inside the tip of the shuck after green food but only to a very slight extent It is rather unusual to find newly hatched larvæ or even eggs on silks less than three or four days old

Apparently the only possible damage these larvæ can do is to cut off the silk before fertilization of the ovules has taken place and a few ears have been found where this apparently had occurred Generally, however, pollination is accomplished so soon after the appearance of the silk that injury from this cause is unlikely

The newly hatched larvæ eat first the minute succulent hairs on the silks After a little they gnaw along the side of the strands and finally consume the entire strand The tissue is so succulent that the larger larvæ can consume a surprising quantity of it in a day

THE PUPA

Description Length 11 mm, width 2 2 mm Head bent so strongly ventrad as scarcely to be visible from above Mesothorax large and produced at each lateral angle into an acute, laterally flattened process extending cephalad 6 mm the prothoracic area between these processes flattened and with eight black dots arranged roughly in a triangle Meso- and metathorax flattened and only slightly convex above, gibbous ventrad Mesothorax above finely rugose and with a shining narrow median carina, posterior margin angularly convex Appendages and wing cases covering the venter of the thorax and extending nearly to the caudal margin of the fourth abdominal segment, the costal margin of the wings extending slightly above the lateral line Ten abdominal segments visible above, the fourth and fifth the longest, cremaster flattened and separated from the tenth segment by a sharp notch on each side, bearing at its tip four pairs of curled hooked spines, the two distal pairs stout, diverging from a single point and turned latero-ventrad the other two pairs much smaller and arising from four minute dusky spots just cephalad of the tip above, and curling toward each other

In color the pupa varies from pale green to deep reddish-brown, always paler beneath The cephalic margin of the mesothorax is marked by a narrow dark line running out to the tip of the cephalic processes A more or less dusky line runs caudad on each side from the base of these processes along the dorsal margin of the wing case and ends on a dusky spot about even with the third abdominal segment There is a pair of small round dark dots on the dorsum of each segment except the prothorax and the ninth abdominal

Pupation When mature the larva seeks a sheltered place somewhere about the plant, sometimes within the lock of silk but more often on the shuck beneath or behind the silk, on the other side of the ear between it and the stalk, or under or within a leaf elsewhere on the plant When pupating in the silk a very slight filmy white cocoon is sometimes formed but in other locations this is dispensed with The larva spins a small pad of brownish-yellow silk within which the crochets of its caudal legs and later the spines of the cremaster remain entangled It also forms a girdle of a single thread attached to the surface on each side and passing over its body between the third and fourth abdominal segments Before pupation the mesothorax becomes greatly enlarged and the head and shrunken prothorax are bent sharply ventrad The pupa with its two cephalic processes is very characteristic and can hardly be confused with that of any other species The pupal period is short, from six to nine days, usually seven

LIFE CYCLE

No attempt was made to determine the duration of the separate larval instars The duration of the entire larval life in summer is very short, from 12 to 18 days Larvæ which completed their larval life in 12 days emerged as moths six days later Three days more for the egg stage makes 21 days for the minimum complete life cycle, assuming that the moths deposit eggs soon after emergence Allowing the average of three days for the egg, 14 days for the larval stage and seven for the pupal stage we have a total of 24 days for a normal average life cycle in midsummer with food abundant These figures check very well with the collection records of the moths where the crest of the waves of abundance came just three weeks apart In the spring and fall with temperatures lower and food not so abundant or palatable, the life stages are undoubtedly of longer duration

PARASITES

The larvæ are freely parasitized but, in our experience, by only one species, *Apanteles nemoriæ* Ashm This same parasite also attacks other small flower feeding geometers (4, p 543) Only one individual matures in a single host larva The mature grubs leave the host through the side in the abdominal region, in one observed instance through the left side of the fifth abdominal segment The host remains alive but motionless for several hours after the emergence of the parasite and finally dies The *Apantales* cocoon is white, 3 mm long and 1 2 mm wide, surrounded with loose silk The adult emerges five or six, usually five, days after the cocoon is formed When adults of this parasite were allowed to attack healthy reared larvæ the grubs left their host eight or nine days later This indicates a very short life cycle for the parasite, scarcely over two weeks Although the cocoons of this parasite were quite abundant at times the parasitism never reached 10% of the larvæ collected in the field and reared Neither did the degree of parasitism increase toward the close of the season

In a few cases this parasite was attacked by a secondary, determined as *Mesochorus* sp , a slender, golden-yellow species This hyperparasite evidently attacks its host while the latter is within the body of the caterpillar The *Apanteles* grub emerges from its host and cocoons normally Nine days later the *Mesochorus* emerges instead of the expected *Apanteles*

OTHER ENEMIES

As mentioned above the larvæ are somewhat cannabalistic They are also eaten by larvæ of *Chauliognathus pennsylvanicus* DeG and both larvæ and pupæ are readily eaten by larvæ of the corn ear worm, *Heliothis obsoleta* Fab One larva was taken by Mr Cartwright impaled on the rostrum of an adult *Podisus maculiventris* Say

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SOME TINGITIDAE FROM JAPAN (HEMIP)*

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Sometime ago the writer received, through the kindness of Mr W L McAtee, a small collection of lace bugs or Tingitidæ from Japan In addition to a few new records the collection contains a new genus and three new species *Galeatus peckhami* Ashm was wrongly recorded by Uhler from Japan, this insect seems to be limited in distribution to the northern portion of the Nearctic region Although I have examined specimens of *Stephanitis pyrioides* Scott from Japan, the species listed by Uhler as this insect (*Tingis pyrioides* Scott) is *Tingis pyri* Fabr

MONANTHIA FORMOSA n sp

Moderately large, rather robust Head short with five appressed spines, posterior spines much longer than the anterior spines, the latter short Antennæ rather slender, moderately long, first and second segments subequal in length, the former a little thicker and stronger, third segment very long and slender almost three times the length of the fourth, fourth segment slightly swollen, clothed with several long hairs Rostral laminæ widely separated on the metasternum, meeting behind rostrum reaching to the intermediate coxæ Pronotum narrowed anteriorly, considerably and transversely swollen through the disc, Paranota strongly developed reflexed back against the pronotum, the outer margins contiguous with the median carina with prominent nervures the nervure next to the outer margin strongly costate Median carina distinctly raised, rather thin, with a row of small areolæ Lateral carinæ short, not very prominent, divaricating posteriorly Elytra moderately constricted a little beyond the middle, considerably longer than the abdomen, broadly rounded at the apex, tumid elevation moderately large, costal area uniseriate throughout, the areolæ rather large, subcostal area triseriate, the areolæ considerably smaller than those of discoidal area, discoidal area extending to the middle of the elytra, slightly unequally reticulated, narrow at the base and broadly rounded at the apex, the outer nervure at the base strongly roundly and outwardly curved, sutural area rather widely and somewhat unequally reticulated Wings a little shorter than the elytra Length, 2 6 mm , width about 1 mm

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Legs and antennæ light testaceous Body beneath black Head black, the spine whitish Paranota whitish, a few of the nervures fuscous Nervures of apex of pronotum and of the elytra mostly fuscous (few testaceous), the areolæ largely whitish and nearly opaque Most of the areolæ of sutural area broadly margined with fuscous

Fifteen specimens, Kankau (Koshun), Formosa, Japan, 1912, collected by Mr H Sauter *Type*, male, in the collection of Dr Walter Horn, Berlin, Germany *Paratypes* in the collections of U S National Museum, Dr Horn and writer In some specimens the fourth antennal segment is slightly embrowned The smaller size, the lighter color of legs and antennæ, and size of paranota separate this species at once from the new form described below

MONANTHIA SAUTERI n sp

Very closely allied to *M formosa* n sp , but readily separated from it by the stouter and more robust form, much narrower paranota (not contiguous with the median carina), nearly parallel lateral carinæ, and the lighter color of the reticulations of the elytra and paranota Length, 2 82 mm , width, 1 3 mm

Pronotum transversely swollen through the disc, coarsely punctate, median carina well-developed, composed of a single row of small areolæ, lateral carinæ short, each composed of two small areolæ, paranota with two or three rows of punctures between its outer margin and the median carina Elytra similar to *M formosa* n sp , discoidal area not quite reaching the middle of the elytra, subcostal area mostly triseriate, with a few extra areolæ at its widest part (back of apex of discoidal area) Wings almost as long as elytra

Antennæ testaceous, the fourth segment mostly fuscous Legs testaceous, the tarsi fuscous Head black, the spines testaceous Pronotum and body beneath black, reticulations of paranota testaceous, the areolæ whitish Reticulations of elytra mostly brown, the cells whitish

Type, female, Kankau (Kushun), Formosa, Japan, May, 1912, collected by Dr H Sauter, in the collection of Doctor Walter Horn *Paratype*, Tainan, Formosa, Japan, 1912, collected by H Sauter, in my collection In the latter specimens the nervures of the elytra are dark fuscous |

BELENUS DENTATUS Fieber

Phyllontochila dentata Fieber, Ent Monog , 1844, p 71, Pl VI, Figs 2–4
Phyllontochila dentata Stal Enum Hemip , III, 1873, p 126
Belenus dentatus Distant, Ann Soc Ent Belg, LIII, 1909, p 116, (*type* of genus)

Several specimens, taken at Anping and Taihorin, Formosa, 1911, by Mr H Sauter

STEPHANITIS PYRI Fabricius

Acanthia pyri Fabricius, Syst. Ent , 1775, p 696
Cimex appendiceus Geoffroy, Ent , Paris, 1785, p 212
Tingis pyri Syst Rhyng , 1803, p 126
Tingis marginata Lamarch, Hist Nat , III, 1816, p 504
Stephanitis pyri Horvath, Ann Mus Hung , IV, 1906, p 54, Ann Mus Hung X, 1912, pp 320, 327

This species was recorded by Uhler as *Tingis pyrioides* Scott from Japan Numerous specimens of the true *S pyri* Fabr are before me from Japan, also one specimen from China

STEPHANITIS PYRIOIDES Scott

Stephanitis pyrioides Scott, Ann Mag Nat Hist , Ser 4, XIV, 1874, p 440
Stephanitis azalaea Horvath, Ann Nat Mus Hung , IV, 1906, pp 55, 56, Ann Nat Hist Hung , X, 1912, pp 323, 333

Several specimens of the true *S pyrioides* Scott have been examined by the writer from Japan

STEPHANITIS GLOBULIFERA Matsumura

Tingis globulifera Matsumura, Senchu Zukai, II, 1905, p 36, Pl 19, Fig 16
Stephanitis globulifera Horvath, Ann Mus Nat Hung X, 1912, pp 322, 330

Specimens of this insect were taken in Japan by Mr. Koebele

STEPHANITIS TYPICA Distant

Cadamustus typicus Distant, Ann Soc Ent Begl XLVII, 1903, p 47, Fauna Brit Ind , Rhynch , II, 1903, p 132, Fig 95
Stephanitis typica Horvath, Ann Nat Hist , Hung , X, 1912, pp 320, 325

A long series, taken at Hoozan, Formosa, during 1908, 1909, 1911 and 1912, by Mr H Sauter

GALEATUS SPINIFRONS Fallen

Tingis spinifrons Fallen, Mon Cim Svec , 1807, p 38
Tingis affinis Herrich Schaeffer, Nom Ent , 1, 1835, Wanz Ins , III, p 73, Pl 95, Fig 290
Galeatus spinifrons Jakowleff, Bull Soc Mosc , I, 1880, p 131 Horvath, Termes, Fuzetk , XX, 1897, p 456

This insect was listed by Uhler in "Summary of the Hemiptera of Japan, presented to the United States National Museum by Professor Mitzukuri," Proc U S Nat Mus, Vol XIX, No 1108, 1896, p 265, as *Galeatus peckhami* Ashmead The comment, "I can find no structural differences to separate these (four specimens from Japan) from the vertible type as it occurs in lower Canada" refers to the true *G peckhami* of Ashmead Horvath has recently described the form listed by Uhler, Proc U S Nat Mus, XXVII, 1904, p 362, as a new species According to specimens at hand *G peckhami* Ashm is entirely of Nearctic distribution and ranges from Wisconsin and Muskoka Lake, Canada, to the Atlantic (*Fide* Bergroth)

XENOTINGIS n gen

Distinctly lacely like the genera Stephanitis, Cadmius, Leptodictya and Galeatus but distinguished at once from those or other allied genera by enormously developed paranota and the strongly recurved outer margin of each elytron Pronotum tricarinate Head mostly concealed by the hood, with five slender, rather short spines, hood narrow, extending to the apex of the head Eyes small Bucculæ meeting in front Paranota enormously developed, strongly reflexed and recurved, the rostrum long and slender, the rostral groove uninterrupted Elytra considerably longer than the abdomen, rounded at the apex, discoidal area broad, not quite reaching the middle of the elytra, costal area broad, the outer margin strongly recurved (rolled) and touching the discoidal and subcostal areas Elytra and paranota widely reticulated Metasternal orifice quite distinct

Type of genus *Xenotingis horni* n sp

XENOTINGIS HORNI n sp (Fig 1)

Pronotum distinctly punctate, transversely swollen through the disc, tricarinate, lateral carinæ thin, parallel, without areolæ, median carina more strongly raised than the lateral carinæ, especially behind Hood narrow, projecting a little in front of the head, a little longer than high, widely reticulated Paranota enormously developed, strongly recurved, projecting high above the pronotum, nearly semiglobose in shape, the areolæ very large and finely reticulated Head rather short, the spines appressed Rostrum reaching almost to the third ventral segment of the abdomen Antenniferous tubercles moderately large Antennæ rather long and slender, first segment a little longer and thicker than the second, third segment very long, slender, slightly curved, more than four times the length of the fourth Elytra broadly rounded at the apex, considerably longer than the abdomen, widely reticulated, the outer margin recurved, discoidal area broad, not reaching the middle of the elytra, with five rows of areolæ at its widest part, sutural area large, widely reticulated, costal area irregularly quadriseriate. Wings wanting. Length, 3.6 mm., width, 1.58 mm.

General color above uniformly testaceous, the areolæ semi-transparent. Body, legs and antennæ a little darker, somewhat more brownish, the tarsi and fourth antennal segments fuscous.

Type, female, from Kosempo, Formosa, Japan, August, 1909, collected by H. Sauter, in the collection of Dr. Horn.

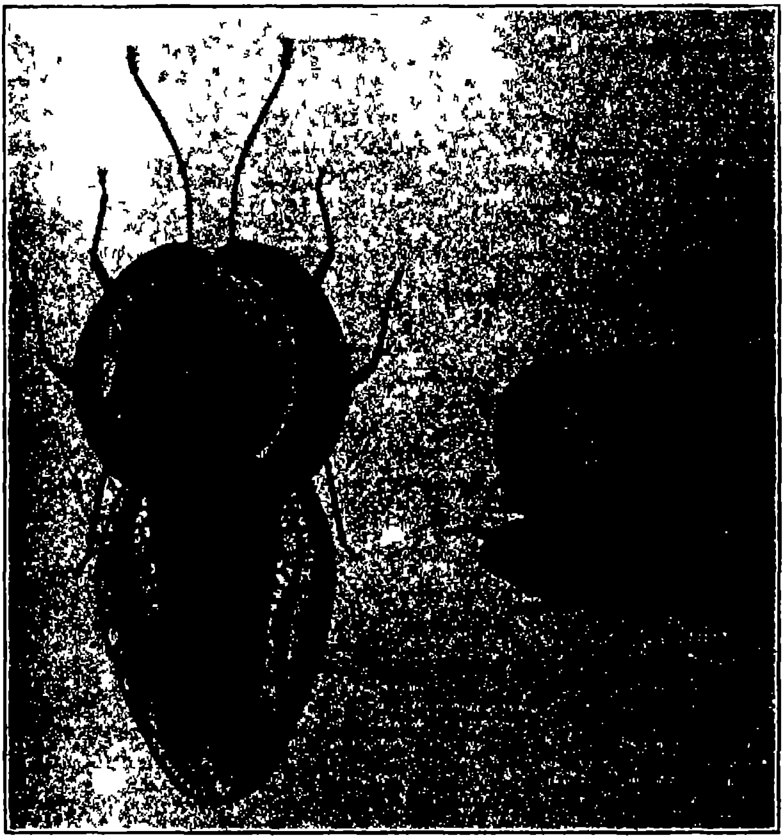

Fig. 1. *Xenotingis horni* n. gen. and sp.

This paper received for publication January 18, 1923.

ADDITIONS TO THE CATALOG OF OHIO VASCULAR PLANTS FOR 1922[*]

JOHN H SCHAFFNER
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Although the flora of Ohio is perhaps as well known as that of any of the States, except a few on the Atlantic border where botany has been studied longer and more intensively, there yet remains much to be done, both in determining the range of the species and the actual species present within our borders

Below is a list of the more important additions contributed by various individuals It is hoped that all interested in Ohio plants and in plant geography in general will continue to send specimens to the herbarium

17 *Pteridium aquilinum* (L) Kuhn Change name to *Pteris aquilina* L Eagle-fern

44 *Matteuccia struthiopteris* (L) Todaro Change name to *Pteretis nodulosa* (Mx) Nieuwl American Ostrich-fern Our species is distinct from the European *Pteretis struthiopteris* (L) Nieuwl

Below is a corrected list of the Ohio species of Equisetum

50 *Equisetum hiemale* L Omit from the list This species is not known to occur east of the Rocky Mountains

51 *Equisetum prœaltum* Raf Great Scouring-rush General in the state and often abundant

52 *Equisetum variegatum* Schleich Variegated Scouring-rush Ashtabula County

52a *Equisetum variegatum jesupi* A A Eat (Probably *E variegatum* X *E prœaltum*) Lake County

53 *Equisetum lævigatum* A Br Smooth Scouring-rush General but apparently not common

53 1 *Equisetum kansanum* Schaffn Kansas Scouring-rush Wood, Erie, Lorain, Summit, Stark, Monroe

53 2 *Equisetum palustre* L Marsh Horsetail Portage County

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[*] Papers from the Department of Botany, Ohio State University No 139

54 *Equisetum fluviatile* L Water Horsetail Not common but to be found in most parts of the state in suitable places

55 *Equisetum silvaticum* L Wood Horsetail Cuyahoga, Geauga

56 *Equisetum pratense* Ehrh Omit from the list Not known to occur in Ohio If present, to be found in the extreme north-eastern section

57 *Equisetum arvense* L Field Horsetail General and abundant

The species should be arranged in the following order to be in the proper phyletic sequence 53, 51, 52, 52a, 53 1, 54, 53 2, 55, 57

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65 *Selaginella apus* (L) Spring Creeping Selaginella At base of wet limestone cliff, Rocky Fork Creek, Highland Co Caves, Highland Co Mrs Bayard Taylor

71 *Pinus echinata* Mill Short-leaf Yellow Pine Colerain Twp, Northeastern Ross Co "Sparsely distributed, confined to the sandstone hills of Harrison and Colerain Twps in this county" Also in Springfield Twp, Gallia Co, and generally distributed in Green, Greenfield, Ohio, and Raccoon Twps F W Dean Correct the following mistake in note on distribution in 1921 "Additions" Read Northwestern Jackson County instead of Northeastern Jackson County

72 *Thuja occidentalis* L Arborvitæ Reported to occur in a few isolated places along Brush Creek in Green Twp and in the Gorge at Cedar Falls, in Jefferson Twp, Adams Co, by F W Dean

108 *Brasenia schreberi* Gmel Water-shield Jackson Twp, Franklin Co, John H Schaffner

109 *Nelumbo lutea* (Willd) Pers American Water-lotus Jackson Twp, Franklin Co Robert B Gordon

133 *Wolffia columbiana* Karst Columbia Wolffia Jackson Twp, Franklin Co Probably quite generally distributed in the state, our smallest flowering plant John H Schaffner

216 1 *Carex suberecta* (Olney) Britt Prairie Straw Sedge Big Darby Creek, Franklin Co Edward S Thomas

331 *Poa brachyphylla* Schult Change name to *Poa Cuspidata* Nutt Cuspidate Spear-grass Specimens collected two miles north of Steece, Lawrence County, by Chas C Deam, of Bluffton, Ind Determined by Agnes Chase, of the U S National Herb Specimens in Deam herbarium Also in Ohio State University herbarium, specimens from Lawrence, Trumbull, Cuyahoga, Perry, Medina and Ottawa Counties

366 *Secale cereale* L Rye "Persistent after cultivation and escaped to waste places " Hillsboro, Highland County Katie M Roads

448 *Panicum boscii* Poir Bosc's Panic-grass Big Darby Creek, Franklin County Edward S Thomas

465 *Holcus halapensis* L Johnson-grass Near Hillsboro, Highland County "According to farmers, it is crowding out alfalfa in alfalfa fields " C J Willard Also "Rather abundant in a pasture field," Berrysville, Highland County, Katie M Roads

483 *Allium vineale* L Field Garlic In a waste field, Columbus, Franklin County John H Schaffner

488 *Ornithogalum umbellatum* L Star-of-Bethlehem Along a road in moist meadow Bloom Twp , Fairfield County John H Schaffner Also "very common in fields and waste places " Hillsboro, Highland County Katie M Roads

528 *Pontederia cordata* L Pickerel-weed Jackson Twp , Franklin County John H Schaffner and Robert B Gordon

532 *Tradescantia pilosa* Lehm Zigzag Spiderwort "In yards and waste places," Hillsboro, Highland County Katie M Roads

558 *Iris cristata* Ait Crested Dwarf Iris "Covered a hillside " Hillsboro, Highland County Katie M Roads

604 *Magnolia tripetala* L Umbrella Magnolia About 6 miles N W of Jackson, Jackson County, headwaters of Pigeon Creek, Liberty Twp "In bottom lands and lower slopes of deep ravines The species is abundant with numerous fine specimens 35–40 ft high and 4–5 in in diameter " "Also in extreme upper

edge of Eagle Township, Vinton County, nearly on the county line between Vinton and Hocking Counties, 4 miles north of Eagle Mills, along ravine near main stream of Salt Creek" F W Dean

623 *Batrachium circinatum* (Sibth) Rchb Circinate White Water-crowfoot Jackson Twp , Franklin County John H Schaffner

629 *Aquilegia vulgaris* L European Columbine "Occasional in waste ground" Hillsboro, Highland County Katie M Roads

641 *Viorna viorna* (L) Small Leather-flower Lucas Co , J W Hawkins, Coshocton Co , Everett Lowary Reported by F Detmers

680 *Fumaria officinalis* L Common Fumitory "On the bank of a small pond" Hillsboro, Highland County Katie M Roads

703 *Thlaspi arvense* L Field Penny-cress Union Twp , Highland County Katie M Roads

712 *Norta altissima* (L) Britt Tall Hedge-mustard "Introduced weed in pasture fields and lots" Hillsboro, Highland County, Katie M Roads Also Columbus, Franklin County, Robert B Gordon

715 *Hesperis matronalis* L Dame's Rocket "Occasional in woods and waste ground, Hillsboro, Highland County Katie M Roads

718 *Barbarea stricta* Andrz Erect Winter-cress "Not common" Hillsboro, Highland County Katie M Roads

719 *Barbarea verna* (Mill) Aschers Early Winter-cress "Very abundant in grainfields and pasture land" Hillsboro, Highland County Katie M Roads

747 *Brassica campestris* L Common Turnip "In a pasture lot" Hillsboro, Highland County Katie M Roads

775 *Linum virginianum* L Virginia Flax "Dry woods" Washington Twp , Highland County Katie M Roads

786 *Brassica juncea* (L) Cosson Indian Mustard "In waste places" Union Twp , Highland County Katie M Roads

796 *Mercurialis annua* L Mercury Columbus, Franklin County John H Schaffner

803 1 *Tithymalus darlingtonii* (Gr) Small Darlington's Spurge "Moist hillside " Hillsboro, Highland County Katie M Roads

814 *Callitriche austini* Engelm Terrestrial Water-starwort Jackson Twp , Franklin County In a moist pasture near pond One of our smallest flowering plants John H Schaffner and Robert B Gordon

927 *Dianthus barbatus* L Sweet-William "Escaped from cultivation " Hillsboro, Highland County Katie M Roads Also in waste pasture-land, north of Columbus, Franklin County, John H Schaffner

932 *Portulaca grandiflora* Hook Garden Portulaca Escaped "In waste places," Hillsboro, Highland County Katie M Roads

976 *Pleuropterus zuccarinii* Small Japanese Knotweed Zanesville, Muskingum County, F M Reed, Hillsboro, Highland County, Charles Johnston Reported by F Detmers

1008 *Potentilla argentea* L Silvery Cinquefoil "Dry pasture land " North of Columbus, Franklin County Robert B Gordon

1009 *Potentilla recta* L Upright Cinquefoil "Rather common in pasture lots " Hillsboro, Highland County Katie M Roads

1022 1 *Rubus laciniatus* Willd Cutleaf Blackberry "A large patch in a pasture lot " Hillsboro, Highland County "In several other places in the county " Katie M Roads

1082 *Cratægus phænopyrum* (L f) Medic Washington Hawthorn Dayton, Montgomery County Wm B Werthner

1160 1 *Lespedeza striata* (Thunb) H and A Japan Bush-clover Reported as escaped in pastures, South Bloomingville, Hocking County Homer C Sampson Probably quite common in the southern part of the state From eastern Asia

1269 *Quercus stellata* Wang Post Oak Jackson Twp , Franklin County Rare locally John H Schaffner and Robert B Gordon

1271a *Quercus imbricaria* x *velutina* Lea's Oak Dayton, Montgomery County William B Werthner

1272 *Quercus marilandica* Muench Black-Jack (Oak) Springfield Twp, Gallia County "On poor clay ridge—in mixture with post and quercitron oaks and short-leaf pine" F W Dean

1329 *Ribes odoratum* Wendl Buffalo Currant "Very common along fences and waste places" Hillsboro, Highland County Katie M Roads

1380 *Anagalis arvensis* L Scarlet Pimpernel Jackson Twp, Franklin County John H Schaffner and Robert B Gordon

1400 *Andromeda polifolia* L Wild Rosemary Cranberry bog, Buckeye Lake, Licking County Planted in the bog F Detmers

1432 *Convolvulus spithamæus* L Upright Bindweed Dry rocky soil, near Girl's Industrial School, Delaware County John H Schaffner

1455 *Chionanthus virginica* L Fringe-tree Along Aaron Creek, two miles west of Arabia, Aid Twp, Lawrence County "Growing in open field surrounded by old field type of Sassafras, sumac, persimmon, etc Upper southwest slope" F W Dean

1502 *Physalodes physalodes* (L) Britt Apple-of-Peru "In a cultivated field" Hillsboro, Highland County Katie M Roads

1537 1 *Veronica glandifera* Pennel Glandular Speedwell Reported for Ohio by F W Pennel, no specimens in the state herbarium Collected at Oxford, Butler County, by Bruce Fink

1540 *Veronica teucrium* L Change name to *Veronica latifolia* L Broad leaf Speedwell, of which it is a synonym

1554 *Aureolaria lævigata* (Raf) Raf Entire-leaf False Foxglove Dean Forest, Lawrence County Reported by F Detmers

1580 *Martynia louisiana* Mill Unicorn-plant Alliance, Stark County, S E Nold, Marion, Marion County, M C Thomas, Uhrichsville, Tuscarawas County, W L Wilcoxon, Barberton, Summit County, L S Swigart Reported by F Detmers

1605 1 *Borago officinalis* L Borage "Introduced in package of herb seed, from Chicago Seed House " In garden, Wooster, Wayne County In herbarium of State Agr Exp Sta., Wooster Reported by F Detmers

1610 *Verbena angustifolia* Mx Narrow-leaf Vervain "Very common in pastures " Hillsboro, Highland County, Katie M Roads

1612 *Lamium purpureum* L Red Henbit Hillsboro, Highland County Katie M Roads

1661 *Perilla frutescens* (L) Britt Perilla "An escape everywhere" around Hillsboro, Highland County Katie M Roads

1696 *Plantago virginica* L Dwarf Plantain "Very common in pastures " Hillsboro, Highland County Katie M Roads

1864 *Bidens laevis* (L) B S P Smooth Bur-marigold Hillsboro, Highland County Katie M Roads

1875a *Galinsoga parviflora hispida* DC Hairy Galinsoga "A common weed in gardens and waste places " Hillsboro, Highland County Katie M Roads

1882 1 *Chrysogonum virginianum* L Chrysogonum Waterford, Washington County, and Peninsula, Summit county In herbarium of State Agr Exp Sta , Wooster Reported by F Detmers

1888 *Boebera papposa* (Vent) Rydb Fetid Marigold "Very abundant in a pasture " Hillsboro, Highland County Katie M Roads

1889 *Inula helenium* L Elecampane "Rare along fence rows " Hillsboro, Highland County Katie M Roads

1903 *Chrysopsis mariana* (L) Nutt Maryland Golden-aster Dean Forest, Lawrence County Reported by F Detmers

1988 *Elephantopus carolinianus* Willd Carolina Elephant's-foot Gallipolis, Gallia Co , C A Smith In herbarium of State Agr Exp Sta , Wooster Reported by F Detmers

2023 1 *Cirsium hillii* (Canby) Fernald Hill's Thistle In fields, Lisbon, Columbiana County G W Armstrong In herbarium of State Agr Exp Sta , Wooster Reported by F Detmers.

2026a *Cirsium arvense integrifolium* Wimm & Grab "The smooth variety of Canada thistle, recognized by Gray, seems to be quite common for it has quite frequently been sent in to the Experiment Station Differs from the typical Canada thistle not only in leaf characters but lacks the horizontal rhizome Edison, Morrow County W J Campbell, North Olmstead, Cuyahoga County, D K Huntington, Piqua, Miami County, Fred DeWees These three counties indicate the scattered distribution of this interesting variety or form of the dreaded Canada thistle Interesting because it is much more easily eradicated than the type" In herbarium of State Agr Exp Sta, Wooster Reported by F Demters

2030 1 *Centaurea solstitialis* L Barnaby s Star-thistle "Frequent in alfalfa fields' Van Wert Van Wert County, Wauseon, Fulton County R A Cave Reported by F Detmers

2035 *Hypochaeris radicata* L Long-rooted Cat's-ear On lawn Wooster Wayne County F Detmers

2035 1 *Picris echinoides* L Bugloss Picris Wheat field, Carrollton Carroll County Charles E Capper In herbarium of State Agr Exp Sta, Wooster Reported by F Detmers

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Emerson McMillin

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THE AIMS OF SOCIAL EVOLUTION *

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Last year Professor R C Osburn addressed us on Some Misconceptions of Evolution While the conception of *organic* evolution is only very gradually being accepted by the population at large, the rate at which it is becoming an established principle among the educated classes, hastens the need for studying the psychological factors that are shaping *social* evolution It is clear to a group of scientists that social problems are experimental problems We are no more able, until we have tried it, to affirm that this or that law is a good one, than we are able to predict the outcome of a new chemical combination on the basis of what we know about cooking or gardening

For those who regard social problems as fundamentally biological in character, what shall be our attitude toward the teleological aspect of all social reform? In natural science this problem never appears The scientist is not ordinarily concerned with getting a specific result, he is after the facts that may be observed under controlled conditions, and when these are recorded he begins his interpretations quite oblivious of the fact that his guinea pigs do not hold his experiment in high esteem

When a sociologist or a psychologist is asked to pass judgment on some contemplated social reform, he is expected to estimate its value in terms of *good* or *bad* in addition to predicting its probable influence on existing conditions When the conscientious investigator seeks a standard of value on which to base his teleology, he finds the literature on this topic overwhelming He is chagrined to learn that every one seems to know what is good and what is bad, except himself He may rest on some such statement as, a good social reform is one that increases the total *happiness* of all concerned His curiosity as to the nature of happiness may expire when he learns that happiness is the condition in which internal and external adjustment are in equilibrium

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* Retiring President s Address before the Ohio Academy of Science, March 30, 1923

Before scientific methods can become very effective in social experimentation, it is necessary to establish the direction in which social evolution seems to be going It is clear that if mankind is to go to the same place where the extinct dodo now is, his social organization ought to be developed along different lines than if he expects to prepare for a career subsequent to his existence on earth It thus becomes the first problem for the psychologist to determine just what physical and biological science have to contribute toward establishing the probable direction of social evolution If the search gives promise of a special destiny for man, well and good

MAN AS A BIOLOGICAL UNIT

From the biological standpoint man is a product of organic evolution, and the ten thousand years of his historical period have demonstrated his fitness to survive in the struggle with non-human competitors This survival is not due to his physical strength His anatomical structures and physiological processes resemble those of the animals so closely that as scientists we ought to assume uniformity in development rather than introduce cataclysmic conceptions based on non-biological entities of a psychic or vitalistic nature Accordingly we should consider man and his achievements as the product of the same forces and conditions that were in operation before he appeared

Man as an organism is an aggregate of sensitive, conductive, contractile, secretory, and supporting tissues, grouped together into the organs, structures, and fluids of the body Within this body the chemical and physical processes of growth, nutrition, reproduction, occur precisely as in animals and if we consider these vegetative processes only, there seems no justification for assuming otherwise than that the human species will inhabit the earth for a time, to be sooner or later displaced by some other form, as different from man as he is from the nearest animal When, however, we observe the extent to which man's presence has changed the face of the earth and compare his achievements with those of any existing or prehistoric form, we may well wonder whether some principle of discontinuity was not introduced with his coming

ORGANIZATION

Suppose we consider first whether cosmic development as far as we can picture it, exhibits discontinuity According to some of the physicists the universe about us is the totality of two entities and their interactions, called *electrons* and *protons* The electron is defined as a unit charge of negative electricity, the proton as a unit charge of positive electricity, and the properties are those of negative and positive electricity as described in the physics text-books The dynamic relations between these entities is expressed as the law that like-signed particles repel each other, while unlike-signed particles attract each other

The chemical elements are to be regarded as different configurations of electrons and protons, the various atoms differing from each other only with respect to the number of electrons and protons that they contain There is, however, a limit to the size beyond which the electrons and protons no longer hold together as a single *atomic structure* This limit seems to have been reached by radium which is unstable under any known present conditions, and is continually breaking down into the lighter atoms of lead and helium However, atomic structure does not represent the limit of cosmic evolution, and the next step in organization consisted in the combination of atoms into a *molecular structure* Molecules combined to form chemical compounds, minerals, substances As the culmination of inorganic complexity we find *crystallization* in which a given geometrical form of molecular organization may grow in size by the addition of the free molecules in a supersaturated solution

The next apparently discontinuous step in cosmic organization was the appearance of the larger *protoplasmic structure,* stable with respect to organization, but unstable with respect to molecular composition While the protoplasmic element (the cell) is larger and more complex than any organic molecule, it also is limited in its size by a surface-mass ratio which is at an optimum between one-fiftieth of a millimeter for the larger protozoa, to whatever may be the size of the smallest filter-passing bacteria

The development of a *multicellular structure* was the next discontinuous step in the direction of complexity in the organization of the electron-proton systems From the smallest scarcely visible multicellular forms whose weight is given in milligrams, we pass by intermediate steps to the huge prehistoric herbivora whose mass is calculated in thousands of kilograms Apparently we have here reached the limit of size and complexity in the multicellular type of organization The large herbivora became extinct and even the larger existing mammals (aside from man's interference) are decreasing in number and are also facing extinction The reduction in size of the multicellular type has not been equal in all the tissues In the progenitors of man, the central nervous tissue actually increased in proportion to the other tissues The direct effect of this increased brain capacity resulted in an increase in the number of interconnections between the sense organs and the muscles Instead of independent reflex sensory-motor mechanisms, the interconnections which became possible as the brain enlarged, increased the range of the stimuli which could release a given reflex mechanism The complexity of behavior was then more closely correlated with the *combination of stimuli* than it was with complexity in inheritance This was the beginning of what we now call learning through experience The animal's behavior no longer depended solely on specific inherited connections but new environmental conditions were able to produce modifications which individualized the organism and made it possible to develop reactions that were not laid down by inheritance Science is just beginning to recognize that this greater behavior range is another discontinuous step through which cosmical organization has been extended beyond the simple multicellular type of the large prehistoric herbivora to a *compound multicellular structure* to which we now give the name of *social organization*

In the relatively unsocialized animals the specialization of the different tissues had already produced a high degree of co-operation between the parts of the body This interdependence of the various tissues, however, became so complex that the probability of fatal abnormalities became too great The inadequate function of a single organ, kills the whole organism With social organization for the group even though the individuals are very highly specialized for certain necessary activities, the death of one individual does not destroy the whole community, as for instance, the death of the heart will destroy the whole body In other words, the difference between man and the animals lies in man's greater behavior potentialities, and this is due to a greater variety in the interconnections between sense organs and muscles This seems at first to be an insignificant distinction but it made language possible and proved of such great survival value that it placed man so far from the animals that his *relationship* to them is still denied by the population at large and has only been accepted by the scientists during the last seventy-five years

SUPER-VARIABILITY

If the essential difference between man and the animals lies in the fact that man's movements are more correlative with the variety of the stimulus combinations which act upon his sense organs, suppose we consider the hypothetical conditions that would produce the maximum variability in human behavior

Primitive man, as compared with civilized man, is limited in the variety of his behavior by the limited range of his sense organs At best he can only react to objects within his visual range, a distance of hardly more than a few miles If an ideal individual existed whose eyes could at any moment, see all the things that have occurred in the past, that are now occurring all over the world, and that will occur in the future, such a superman would exhibit a diversity in his behavior far beyond that of any normal man With such eyes the superman could discriminate environmental details beyond the range of the normal individual Such eyes are of course, a physical impossibility but we shall presently see that certain social institutions really make it possible to approach this all-seeing condition Suppose further that our superman possessed perpetual youth, absolute immunity against disease, the best possible inheritance, unlimited physical strength, and unfailing food and shelter resources Even if such a superman lived at the same place and time as a normal individual his behavior would differ from that of the normal man The biological structure of the normal individual is such that many of the environmental stimulating conditions do not produce correlative sensory-motor changes In our superman the normal biological limitations do not exist and hence his sensory-motor changes would exhibit a higher degree of correlation with the environmental conditions This is what we mean when we say that the superman is in better equilibrium with his environment than is the normal individual

Compared with the normal man, our superman may be characterized as omnipresent, omniscient, and omnipotent In the cosmical sense the superman is an aggregate of electron-proton systems whose changes exhibit the maximum correlation with the changes that are occurring or have occurred in all the other electron-proton systems in the universe *Homo sapiens* approaches the variability of our superman to a greater extent than does any other animal but even the best endowed individual is far from the ideal Yet, I expect to show that social organization is one of the devices by which normal man comes nearer to our superman

We now pass on to consider more in detail some of the limiting conditions which separate the existing man from the superman

BIOSOCIAL LIMITS TO VARIABILITY

The most important conditions which limit the freedom of action of the normal individual may be grouped under five headings (1) The limitations of disease and death, (2) Limited sensory capacity and restricted environment, (3) Limitations through faulty inheritance, (4) Limitations through essential food and shelter activities, (5) Limitations imposed by the competition between individuals

To anticipate our conclusions we may provisionally regard human institutions and organizations as agencies by which man actually overcomes some of these limitations, and that social reform or social changes are directed toward developing the one best type of organization that will make it possible to secure the maximum variability for each individual and thus produce indirectly an electron-proton organization which approaches the omnipresence, omniscience, and omnipotence, of our superorganism We pass on to a consideration of the extent to which social organization has already overcome many of the limitations against the maximum variability in behavior

(1) *The Limitations of Disease and Death* Under favorable conditions the span of life lies in the neighborhood of seventy years, the average length between forty and fifty It is clear that if the individual lives to three hundred years and retains perfect health during this period, the variety and number of his achievements would be greater than they are now, just as under primitive conditions they were less than at present From the development of medicine since primitive times we see that the

activities of the physician have become very specific Medical education and the various types of treatment now represent varieties of behavior that are very complex and take up the full time of a considerable percentage of the population Through the innate variability of the best endowed individuals, medical research has developed sanitary and hygienic methods which have displaced the ritual and magic of the primitive medicine man The greater complexity in medicine requires every other member of the community to increase his output in order to furnish the food and shelter for the medical profession, but on the whole the actual leisure of the community is increased, and the probability of still more effective inventions and discoveries becomes greater

The following are some of the social institutions and co-operative forms of behavior which reduce disease and delay death Medical education, hospitals, preventive medicine, sanitation, safety first methods, vital statistics, etc These institutions can only exist under a very complex form of social organization, but even the most advanced medical practice and organization is hardly more than a beginning Such very effective methods as health control through heredity have not even been tried It seems reasonable that in so far as medicine is a factor in social evolution it points to an increase in the size and the complexity of social organization, and adds variety to human behavior

(2) *Limited Sensory Capacity and Restricted Environment* Anatomically the sense organs of man are of the same general type as those of animals He sees, hears, smells, tastes, feels, in about the same way, in some cases more accurately, in others less The animal is limited, qualitatively, by the lack of sense organs for the discrimination of such physical forces as electricity, magnetism, certain forms of radio-activity, spatially, by the fact that a radius of at most a few miles represents the maximum distance at which a stimulus may act, and temporally, in that only the stimuli that occur in the immediate present can be effective in modifying its behavior Compared with the savage, civilized man has enormously extended the range of his sense organs and his environment by the invention of language Through language man is able to practically reproduce environments that have occurred in the past or may occur in the future, or which are occurring now but are beyond the limit of direct observation Thus by the aid of historical language

records man may at any time reproduce situations that occurred centuries before he was born Through the newspapers, magazines, books, illustrations, the cinema, he can extend his environment to any part of the earth Through his radio outfit he is able to hear New York's latest jazz Through advanced weather reports he is able to adjust himself to temperatures that will not act on his cutaneous receptors for many hours Contrast this with the limited sensory range and restricted environment of primitive man and we see how the range of modern behavior is extended, not only for the individuals who use the devices but also for those who develop and produce them These inventions and the social organization through which their products are distributed have the virtual effect of placing the sense organs and the environment of every individual, living or dead, at the disposal of every other individual We have learned how the past, present and future, the near and the far, can be stored in a library

The following devices and institutions extend the sensory range and the environment of civilized man and thus produce greater variability in his behavior Formal historical records, and the many forms in which language manifests itself, cinema, photographs, and other forms of representative art, microscopes and telescopes, radio, power, travel

It is only by marshalling such an imposing list of social achievements that we get an idea of how the development of the central nervous system has made possible a degree of interaction between organisms entirely beyond the anatomical possibilities Social organization in the realization of its potentialities will unite all men into one gigantic organization, the individual units of which are only multicellular organisms that exhibit *both* uniformity and variety in their behavior

(3) *Limitations Through Faulty Inheritance* Under any given set of environmental conditions all the individuals of a group do not develop the same reactions Some individuals meet new situations by improving upon established forms of behavior, others cannot even learn to imitate the established reactions There are thus differences between individuals that are traceable to differences in the type of nervous system that is inherited, and these differences may range from an imbecility which would result in the speedy death of the individual if left to himself, through various stages of dependence and independence, up to the leader who invents and discovers many

new forms of behavior better adapted for survival than those that have been established Excellence in inheritance thus manifests itself as a quicker learning and an improvement of the standardized reactions Good inheritance has been recognized as such an important factor in social adjustment, and as occurring so rarely, that most individuals are taught to *imitate* the behavior of the well endowed rather than to rely upon their own innate ability This results in behavior that is considerably above the average inheritance level of the group Factory methods make it possible to produce cheaper and better products with workers of poorer inheritance and training than did the older handicrafts This should release the abler workers for further research, but at present this better inheritance goes to produce profits for private individuals instead of for the community It is only very seldom that the inheritance and training of the profiteers is directed toward improving the type of social organization

When the inheritance of the individual is so poor that he does not learn the standardized reactions, as in insanity, feeble-mindedness, idiocy, the persistently criminal, the unemployable he becomes a charge on the community and does not even contribute his share toward the maintenance of the social organization This further drains off the resources into non-productive channels

The home, tradition, law, education, division of labor, etc , make it possible to use types of inheritance that would be speedily eliminated under more rigorous primitive conditions but no fundamental scientific attempt has been made to improve the germ plasm of mankind

(4) *Limitations Through Food and Shelter Activities* Under frontier conditions practically the whole time and energy of the family are devoted to securing food and shelter and these are of the simplest kind One of the first steps after social co-operation has begun is to establish some kind of religious or educational activity which introduces variety into the behavior of the younger generation and prepares them for participation in still more variable forms of behavior Roads and transportation facilities are improved and through the division of labor and the use of machinery the time and energy devoted to food getting are much reduced, and the greater leisure is expressed in a greater variety and better quality of food and shelter Perhaps in no other field of human activity has social organization pro-

duced such a variety in behavior as in the preparation of dress, food, and shelter

It is difficult to name a social activity that does not in some way relate to food and shelter, but among the institutions which reduce the time and energy devoted to securing them we may mention factory methods, transportation, refrigeration, improved agriculture, improved housing, and such indirect methods as insurance, pensions, etc

From even a hasty consideration of the complexity and variety of institutions such as these it seems evident that biological evolution beyond the huge multicellular forms of the primitive herbivora has taken the form of an increased complexity in behavior, and this in turn is secured through an increase in the relative amount of nervous tissue If we are correct in assuming that cosmical evolution, in so far as this term has any significance, is in the direction of the formation of larger and more complex aggregates of organized electron-proton systems, the activities of the highly individualized multicellular form known as man, exhibits this tendency in his food and shelter organization in an almost irrefutable clearness

(5) *Limitations Imposed by Competition* While competition introduces variety into the behavior and develops inventiveness for a few of the abler members of the group, too large a proportion of it is directed toward decreasing rather than increasing the community's resources Under primitive conditions where social organization is limited to rather small groups, competition in the shape of war may take up all the time and energy of a considerable part of the group Even under modern peace conditions there is a constant lack of balance between the workers and the amount of work to be done which results in an actual reduction in the variety of behavior

Social organization has made least progress in the elimination of useless competitive behavior The most effective instrument, that of scientific research, has scarcely been introduced Such institutions as civil service, vocational or specialized training, labor unions, employers' organizations, producer's organizations, trusts, treaties, and agreements, have eliminated or regulated competition, between particular groups of individuals, but this is usually nothing more than a transference to a less organized group Thus the coal operators may combine to limit competition among themselves, the miners may organize for higher wages, but there is no decrease in the cost of coal to the unorganized consumer However, ineffective modern business methods may be from the scientific standpoint or as compared with engineering, they are the first steps toward a more equitable distribution of commodities which in turn will result in greater variety in behavior

LIMITED VARIABILITY

We have seen how social organization is a device for overcoming the restrictions which limit the variability of human behavior, particularly as referring to disease and death, sensory capacity and restricted environment, faulty inheritance, essential food and shelter activities, and competition We profess to see in this a cosmical evolution of electron-proton aggregates into a greater and more complex organization The evolution is not smooth and uninterrupted At times the processes of disorganization seem to have the upper hand Thus it is urged that as economic pressure is removed the variability of man's behavior becomes less rather than more, that if man is required to work less he will loaf more This is undoubtedly true for a large proportion of the population at present For most individuals greater leisure is merely an opportunity to "catch up sleep" or to secure the required rest for adequate metabolism Aside from the inactivity that greater leisure induces under unfavorable nutritive and shelter conditions, the daily tasks are not the ones most individuals would perform if they were independent of their social environment The behavior which would occur if only inheritance and an irresponsible immersion in a social environment were operative (the so-called instinctive behavior) does not fit the individual for any given social status In other words, civilization is largely a process of substituting standardized reactions for those that have been inherited This is a slow process mediated by other individuals (parents, teachers, instructors) not all equally effective in manipulating the environmental conditions for producing the change Thus, even with similar original endowment, limited variability may result from differences in training

Another source of limited variability in behavior results from the fact that social organization has produced a standardized behavior which reflects a better inheritance than most individuals actually possess In other words, the daily activities of the greater part of the population are actually above their inheritance level If now, the average individual secures more leisure he will not devote this to art, literature, science, which are on an even higher inheritance level than his vocational activities, but he will *relax* to recreation that is nearer his own inheritance level, the movies, cards, foot-ball, base-ball, hunting, fishing, etc Unless the individual is educated how to spend his leisure he can only spend it on the level of his own innate capacities, and for the average individual this is not much above that of a normal twelve-year-old child To expect a laborer to spend his spare time in "improving his mind" is biologically unwarranted until we introduce a eugenic and educational program so different from anything we now have that it need not be considered Under present conditions there will always be a relapse into more primitive and more instinctive forms of behavior whenever social pressure is removed Any reform in the direction of better working conditions and shorter hours for the masses which assumes that the added leisure will be devoted to intellectual pursuits, is doomed to failure

Social organization and the processes of civilization are devices by which man approaches omniscience, omnipotence, and omnipresence, but we can now realize that there is no danger of breaking any speed laws The unification and the individualization of behavior which represent the biological essentials of this aim, are well started but our social organization is still very far from adequate to enable each individual to develop the maximum variability which could be expected from his inheritance and an ideal educational system

THE INDIVIDUAL-SOCIAL COMPONENTS IN BEHAVIOR

As the individual learns to adjust himself to his environmental conditions, his behavior varies in two directions It may become more like that of other individuals and contribute to the necessary activities of the community, or it may become more individualistic and conform more closely to his inherited sensory-motor conditions Practically all adult reactions have been highly socialized, yet even in the most standardized reactions a personal or inherited peculiarity can always be pointed out Every adult reaction began as some infantile reaction in which the inborn or individual component alone was operative Through the subsequent stimulating conditions, the infantile reaction is changed, either by the addition to it of other movements, by the elimination of some movements, or by the elimination of some and the addition of other (substitution) movements Every act that we now perform represents a terminal stage in a regressing series of changes which began with some original or first response Each step in the series represents a change (small or large) from the preceding step Theoretically it should be possible to trace back every adult act to some infantile source but the changes are so rapid and the relations between successive steps are so obscure that the analysis into the inherited or acquired components is practically impossible The cause of each change is usually a social stimulus of some sort, a teacher, book, friend, etc The further back the series reaches the stronger the individual component manifests itself The nearer the series approaches the present, the stronger the social component becomes and the more effectively does the behavior establish the social status of the individual The behavior of every person who actively participates in the workaday activities of the community is being constantly brought into closer unity with a communal or special group average, but the process of socializing is always superimposed upon the individual component, which acts as a desocializing force and tends to individualize behavior

A concrete illustration will relieve the abstract character of the discussion Suppose a hundred seniors are asked to write a theme on civics, of a specified length, and within a limited time Assume that they are free to write on any phase of the subject and that every student does his best When the papers are examined it is found that not all the papers cover the same phases of the topic The historical, political, theoretical, ethical, international, industrial, economic phases will be emphasized in very unequal degrees, and will be treated with very unequal degrees of merit This variety or individualization of the papers even though the instructions for each student were the same, represents the individual component The fact that the topic of the theme, its length and the interval within which the paper was completed, was practically the same for all students, represents the social or the unifying component in the behavior

Beginning with the movements of a new born infant which are to be regarded as reflex sensory-motor mechanisms either inherited or of embryological origin, there is a gradual increase in the number and complexity of those movements that make up behavior through youth, maturity and old age The *reaction* to the environment at any given instant may be regarded as one stage in a *series* of reactions which trace backward to infantile reactions and forward to a terminal stage in the daily life of the individual The *behavior* at any given instant may be regarded as a *unified* group of reaction segments from different reaction series The character of each series shows the effect of the environment and inheritance, classified into an *individual* and a *social* component, as follows

A The Individual Component	*B The Social Component*
1 The type of nervous system that is inherited (pugnacious)	1 The type of nervous system that is acquired (Obedient)
2 The stimulating conditions that represent the primitive and relatively unsocialized environment (The out-of-doors)	2 The stimulating conditions that represent the most recent and most socialized environment (School or office)
3 The effect of inheritance or special training in the synthesis of new reactions	3 The effect of conventionalized training in the formation of new reactions
4 The earlier stage (as compared with the later) of a reaction which is being modified	4 The later stage (as compared with the earlier) of a reaction which is being modified
5 The type of behavior popularly designated as an end in itself, recreation, play, personality, originality	5 The type of behavior popularly designated as a means to an end, routine, work, impersonal, and unoriginal
6 The social conditions which differentiate and individualize behavior	6 The social conditions which standardize and conventionalize behavior

THE INDIVIDUAL-SOCIAL COMPROMISE IN BEHAVIOR

The life history of the individual represents a series of compromises between the actions which he actually performs and the ones he would perform if left to himself The question arises, why does the individual modify his behavior to conform with the unity demanded by society? The answer is that many individuals (the socially abnormal) *do not* But under ordinary conditions the *social* environment into which the individual is born, soon becomes the strongest stimulus This means that our social organization from the very beginning presents stimulating conditions (education) that unify behavior rather than individualize it The *innate* tendencies are in the direction of individualization and usually opposed to socialization There is so to speak, a constant fluctuation between old and new forms of behavior Often it is impossible to enumerate the conditions which cause either the new or the old forms of behavior to appear, and to the individual there seems to be a conflict which he is able to decide through some sort of a mental act that is independent of the stimulating or nervous conditions which are operative at the time This is an illusion and merely an expression of the fact that the individual is unable to designate what biological causes were effective in the action that actually prevailed

As a problem in social organization we may agree that the more the individual component can be made to contribute to socialized behavior, the nearer do we approach the maxim effectiveness of the individual as a member of a given social organization In order to participate, the individual must act on a schedule and fit his behavior into a system which may deviate widely from his individual schedule or system The ideal conditions would be those in which the unmodified individual behavior plan would fit into some phase of the social plan Such an ideal synchronism between the individual and social components occurs very rarely, but for each individual there is a social plan which fits his innate capacities better than any other Thus to make a professional musician out of a child whose innate musical ability is low, will require more supervision and training per unit of improvement than in the case of a child who has inherited musical talent and for whom work in music would be individual behavior If further, the musical individual is able to use his talent to meet his vocational requirements, as in teaching music, musical composition, conducting an orchestra, etc , his socialized activities will be almost identical with his innate capacities This will give the most favorable conditions for developing the *art* of music Speaking generally this means that the individual's innate endowments may contribute socially necessary activity His work then becomes his hobby, work becomes play, the right man is in the right place, etc

The individual-social compromise in behavior is merely a statement for the fact that every adjustment that an individual makes to a new environment is a compromise between an older established reaction to the nearest similar environment, and the new stimulating conditions that produce a change in the established reaction

HAPPINESS

In the more democratic forms of government any reform which would entail a permanent reduction in the total so-called happiness would be regarded as a failure This will generally be accepted as a fundamental principle, but when we actually examine what the phrase means, we find it so vague that it will support any argument The writers on ethics are agreed that any attempt to designate the concrete circumstances under which a given individual will be permanently happy is hopeless It is not my intention to consider happiness from the ethical standpoint, but as a *relationship* between the amount of individual behavior, and the amount of socialized behavior

From the cosmical standpoint we found that the superiority of man over the animals was due to the greater variability of man's behavior Therefore any condition, which, in the long run favors variability in behavior has a survival value, and any condition which limits variability, has no survival value In other words, "the active man will inherit the earth and the lazy man will perish" Can we say that the greater the activity, the greater the happiness? If activity is taken in the strictly muscular sense as the amount of chemical energy converted into heat and work, then activity and happiness have nothing to do with each other Evidently the *kind* of activity is important It is usually recognized that greater activity is shown when the individual component (play) predominates than when the social component (work) predominates Without taking the quantitative aspect too critically we may regard the individual component as the numerator and the social component as the denominator of a ratio which roughly measures what we may call biological happiness The greater the ratio the greater the happiness Neurologically, happiness means that the nervous system of the individual is being exposed to those environmental conditions which support the maximum individualization of behavior Happiness in this sense is not a vague psychical feeling or a mysterious entity within the individual It is merely an indication that the activities of the individual are conforming to those biophysical and cosmical principles which will in the long run produce larger and more complex electron-proton aggregates and larger and more complex social organizations

Much of the popular theory on social organization assumes that an increase in happiness also entails an increase in misery at some other point, and the extreme view that happiness is in some way an evil, still has adherents The more highly organized a community may be, the greater are the possibilities for using the innate capacities of the individuals for increasing the effectiveness of the standardized or required activities It is possible therefore, to reduce the essential drudgery in life to a minimum Through such devices as job analysis, individual analysis, and by fitting the two together, the individual-social ratio (standard of living) of the population can be raised enormously

Through the aid of written language the range of the sense organs is much increased, industry, machinery power, sanitation, have removed other limitations against the freedom of behavior However, the very conditions by which some limitations are overcome also introduce new standardized forms of behavior In fact, under our present highly civilized and specialized system, the life of an unskilled laborer may actually be less individual than that of a savage The boredom of the idle on the other hand, is often merely the social condition in which the training of the individual has not gone far enough to prepare him for the type of variety available under the social conditions By clearly recognizing that civilization is merely a device for extending the range of human variability in behavior, the conception of human happiness can be given a biosocial significance which is relatively independent of the fluctuating ethical and moral standards which vary so much from country to country and from decade to decade The aim of civilization then becomes one of co-operation for creating opportunities so that every individual while on earth may establish an optimum relation between his individual and social components in behavior Such a conception reveals clearly that happiness can only be a reciprocal process The behavior must conform with our inherited and acquired capacities and in the long run must be in the direction of increasing the total variety of behavior through the development of larger and more complex forms of social organization

In so far as social science has developed a working hypothesis, this is based on the old assumption that man is the center of the universe and that everything revolves around him It is assumed that man knows what he wants and the only reason he does not get it is because he is so selfish that he wants more than the available resources of the earth can supply That happiness is not a matter of wealth, we know, even though most of us are willing to take a chance on handling a larger amount of it than we actually possess As a matter of fact we do not know what conditions are most favorable for happiness This is just as much an experimental problem as any medical problem The greatest development which can take place in social theory would be the recognition that human behavior is not the result of hate, love, fear, anger These are but names that came into use before we knew the biological basis of behavior When a man has an epileptic seizure we no longer say he is possessed of the devil, why should we ascribe the act of murder to the devil of revenge? It is high time that the brain and nervous system are regarded as biological structures rather than supernatural agencies in radio communication with a celestial spirit reservoir It is the brain and nervous system that is the organ of behavior and the brain is no more the organ of an abstract intellect than the heart is the organ of love Whatever we may include under the term happiness, it is a problem for science, not for poets, politicians, or mystics

THE HISTORICAL BEHAVIOR RECORD

A much larger percentage of the population is beginning to see that human behavior need not be regarded as the product of unknown forces originating out of magical and superstitious principles The improvement and the more widespread teaching of science and of history reveal a uniformitarianism between successive historical periods which is of the same order as that of the geological or biological record The educated man is slowly beginning to class human behavior with human digestion, respiration and circulation From a statistical analysis of the behavior of historical persons and groups, hypothetical life histories and behavior types are being developed and incorporated into our educational system as biological factors in the modification of conduct From the historical record, man's destiny seems to be a biosocial destiny What he does depends on the type of nervous system he has inherited and the social environment into which he was born Today's behavior is the result of yesterday's actions and the cause of tomorrow's behavior Individuals are forming groups, groups are forming federations, states, nations, alliances, and an attempt has even been made to form a league of nations The final stage in which all peoples on earth will be united through some organization may be a long way off, but it is biologically inevitable War cannot prevail because it can only use scientific methods destructively and soon becomes self-limiting because of the expense At present it is a race between science in social organization and science in war, in which scientific social organization will eventually prevail

SUMMARY

Cosmical evolution is a relatively discontinuous process in the direction of an increase in size and an increase in complexity of the ultimate electron-proton elements out of which the universe is constructed

The *inorganic* organization of electrons and protons produced the atom, the molecule, the crystal, the *organic* organization of the molecule reached one limit in the protoplasmic cell and a second limit in the large multicellular herbivora *Social* organization begins with the development of the multicellular organization such as the bees, ants, wasps, and terminates in man The relatively greater amount of nervous tissue in man's progenitors resulted in a greater variety in their behavior A greater variety in behavior made possible an adjustment to environmental conditions for which no specific provision had been made by inheritance This has been called learning by experience The social organization of man is a double process one phase directed toward an individualization of behavior, the other toward a standardization of behavior The aim of social evolution as a cosmical process is that of producing larger and more complex electron-proton aggregates, but as a human process, the aim of social evolution is that of developing a social organization that will yield for each individual a maximum of individualization with a minimum of standardization The ultimate realization of these conditions will produce a social organization and a type of individual that have as upper limits those conditions best described as omnipresence, omniscience, and omnipotence

To rephrase this less technically and stressing popular conceptions of little scientific utility, we may say that man's morality, his culture, his aims, and his aspirations, are limited by certain biological restrictions Within these restrictions his behavior may vary between wide limits The best morality, the best culture, can only be determined by scientific methods They cannot be determined by the methods of poetry, magic, of superstition When the best morality, the best culture, have been determined, their achievement will again depend upon a scientifically developed social organization

When we contemplate what science has done for us let us realize that so far we have only been called upon to *accept* Will we *give* to science with as good grace?

Physical science has given us better shelter, better transportation, better communication, better of all that which is material and has asked naught of that which is based upon our emotional heritage

Biological science has given us better food better bodies, better of all that through which man's conduct may express itself, but in its demand upon our faith and belief in the theory of organic evolution it is asking for what to us, at one time *seemed* a spiritual sacrifice, and *is still*, a spiritual sacrifice for unschooled mankind

Social science has given us better protection, better organization, better training, better of all that through which man approaches a destiny which we only fearfully and with awe contemplate as omnipresent, omniscient, and omnipotent, but its demand upon our courage to sacrifice long cherished beliefs and ideals, to a cold but inexorable scientific method which brands many of them as illusions and errors, is now all but impossible for the elect in knowledge and unthinkable for humanity in the large Will we learn to give of our great faith in tradition, as freely as we have accepted our greater creature comforts?

EMERSON McMILLIN*

BY

Dr T C Mendenhall

For more than a quarter of a century the name of Emerson McMillin has been a familiar one to members of the Ohio Academy of Science Annually throughout that period, with unbroken regularity, a check bearing his signature has been received by the Academy, the proceeds of which were devoted to the encouragement of scientific research, through small grants of money, generally, though not necessarily, restricted to its own membership

Personally he was known to a very few members of the Academy, but in the busy world of finance, material development and courageous enterprise he was known as a great leader

Public utility engineers placed him in the very front rank of their profession He was chosen to membership in many of the leading scientific and technical societies and for several years he served as the president of the New York Academy of Sciences

Artists and musicians found in him a generous though keenly critical patron and in the discussion and study of world problems his reputation was international

These things and many more are put down to the credit of one who ended the period of his formal education at the age of ten years, beginning his struggle with the world as a common laborer in a charcoal-burning iron furnace, at a daily wage of twenty-five cents The story of the succeeding three score and ten years is like a fairy tale, though it is the story of a life in which fairies played no part Few men who have risen to distinction owe less to fortuitous circumstances than Mr McMillin and few have been so entirely "self made," in the best sense of that hackneyed phrase

Aside from the indebtedness of the Academy to him for continued financial assistance, a body mainly composed of those professionally employed in the training of young people may well pause to consider a career so full of inspiring example and high ideals

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*Read at the meeting of the Ohio Academy of Science at Oberlin, on March 31, 1923

As one might infer from his name, Mr McMillin was of Scotch ancestry, his great grandfather having emigrated to America early in the eighteenth century His grandfather, Edward McMillin, born in Virginia in 1765, lived to be eighty-nine years old, and his father, William Reid McMillin, was born in 1803 and died in 1881 In view of his great interest in astronomy it is perhaps worth while to record the fact that I have been able to fix definitely the age of his grandfather through Mr McMillin's recollection that on the day of his burial the sun was almost totally eclipsed, the date thus ascertained being May 16th, 1854

All of his ancestors were people of long life and sturdy physique and from them Mr McMillin inherited unusual physical strength and rugged health

One of the younger members of a family of fourteen children, he was born in the small village of Ewington in Gallia County, Ohio, on the sixteenth of April, 1844 He died, after a short illness, on May twenty-first, 1922, at Darlington, his country seat in New Jersey

During the first ten of these seventy-eight years his life was little different from that of thousands of the sons and grandsons of the hardy pioneers who emigrated from the colonies of the Atlantic coast to the Ohio valley

There was the usual one room school in which the curriculum was limited to the "three Rs," though Mr McMillin remembered that during one term one pupil studied English grammar, and during two terms geography was taught to one class

It is not unlikely that his leaving school at the age of ten years was due, not so much to a necessity for self-support as to the fact that, considering the grasp of his mind and the rapidity with which he acquired information, he had at that early age absorbed and assimilated all that the small country school had to offer him

But his love of study and thirst for knowledge did not end with his farewell to the twenty foot square school room, although it was his last and only opportunity for systematic instruction

It is important to note, also, that work—hard, physical work—was to him a joy and he found in every task something upon which his active mind might feed

Employed as a common laborer around an iron furnace in what is known as the Hanging Rock iron region, in two years he had mastered the mysteries of the engines, boilers and all other machinery used in such a plant, and at the age of twelve was regularly enrolled as Assistant Engineer of the furnace, having full charge of all machinery from twelve at noon to midnight, receiving a wage of fifteen dollars a month, with board and lodging, the latter being in the engine house itself

At fourteen, being a lad of unusual physical strength, he discovered that he could improve his condition financially by becoming a wood cutter and charcoal burner, an occupation which held him until he was seventeen years of age

In the meantime, in spite of the fact that twelve hours out of each twenty-four were spent in hard labor, he found other hours for reading and study In this he profited greatly through the possession of a remarkable memory For example, besides being able to spell correctly every work in McGuffy's spelling book, he could tell whether the word was in the upper or lower half of the page, and in which of three columns it would be found

In a letter received a few years ago he told me of his first interest in the science of chemistry, which was developed during his charcoal period, though at that time he had neither seen nor heard the word "chemistry"

That he was getting something of a hold upon the science, as yet nameless to him, is proved by the fact that being allowed to construct a charcoal "pit" or furnace according to his own plans, he got from it an increase of twenty-five per cent in quantity, as compared with the usual form, while the quality was so much improved that his charcoal carried off all the prizes offered by the furnace company

At the age of seventeen years he responded to Lincoln's first call for volunteers, enlisting as a private soldier in the Civil War, from which he returned more than four years later, a commissioned officer, with five wounds testifying to his courage in action He was one of six McMillin brothers, all of whom entered the army, three only returning alive

From 1861 to 1865 were four memorable years in the life of Emerson McMillin In addition to the ordinary accoutrements of a soldier his knapsack always held three books One of these was a textbook on astronomy, another on geology, and a third on chemistry The astronomy enabled him to study the heavens intelligently while standing guard at night, the mountains of West Virginia, where most of his campaigning took place, afforded excellent opportunity for illuminating the text on geology, with practical chemistry not much could be done, but that came later

Soon after the close of the war Mr McMillin found congenial employment in a small gas works of which he shortly became manager This offered an opportunity for the study of chemistry in a laboratory, which he immediately created and in which he could often be found at work until two o'clock in the morning It was also his introduction to a field of industrial activity in which he soon reached the first rank, for along with the scientific knowledge and technical skill which he acquired with wonderful rapidity, he developed a keen understanding of financial problems, especially those involving projects in industrial engineering

He became, indeed, an engineer in the broadest and best sense of that word His preparation for the many sided activities in which he was gradually absorbed demanded a degree of enthusiasm, industry, courage and capacity for work extraordinary, even for that period, though not so rare then as now The generally recognized absence of these qualities in many of the present generation of young men is often explained and excused by the statement that it is a necessary aftermath of war and that the same condition existed for several years after the close of the Civil War One who had much to do with young people during that period ventures to record a strong denial of that assertion

To the great majority of those who served through those four years the Civil War was an invigorating and toning experience The Emerson McMillin, aged twenty-one at the end of the war, was, in many respects, far more than four years in advance of the boy who entered the army at seventeen

He had learned to hold himself under the most rigid discipline A good many years later, when he was at the culmination of his career as a Captain of Industry and a successful financier, I was his guest for a few days at his home in the city of New York Although he had then passed the meridian of life, as it is usually fixed in years, his capacity for work and for the rapid absorption and assimilation of information was undiminished In the evening he would engage his guest in a discussion of some of the latest advances in physical science, which might last two or three hours, then two or three more hours would be passed, most delightfully, in his large and rapidly growing gallery of paintings By this time the small hours of the night would be at hand and the guest, who just then was throwing off all duties and responsibilities and running away from work as fast as he could, was quite ready for an "intermission" knowing that Mr McMillin would still have a few hours at his desk before ending his day

During fifty years of his life five and a half hours only, out of every twenty-four, were allotted to sleep and almost invariably he was in his office on Wall Street before any of his clerks, often anticipating the arrival of the janitor

Though always reluctant to speak or write of himself or his work, in response to my earnest request for some details regarding his early life, he sent me about three years ago, a most interesting letter, from which I quote the following concerning his personal habits and tastes

> "For twenty-five years I devoted five hours per day to the study of some branch of the sciences that was useful to me Later, when my work became largely financial I devoted that five hours per day to other studies, but systematically, Art (painting, chiefly), History of Music, French, Social and Political History, etc , never less than one year, and in one instance, five years to one study My sleeping hours were five and a half out of twenty-four, for fifty years"

Mr McMillin's management of the small gas works soon attracted attention My own first knowledge of and contact with him came about this time, when Dr Edward Orton, then president of the Ohio State University, whose appraisement of young men was almost unerring, remarked to me, "There is a young man down at Ironton of whom we shall hear great things one of these days, his name is Emerson McMillin"

Though self taught (with the aid of a text-book) Dr Orton had found him well informed regarding the geology of the region and sound in his geological reasoning

He had mastered Civil Engineering sufficiently to enable him to locate and survey a line for a railway in Southern Ohio, and his report included an excellent discussion of the mineral resources of the territory to be served

His activities in this direction very naturally created in him an interest in the manufacture of steel and iron and for several years he was engaged somewhat extensively in that industry in addition to that of the production of artificial gas, which was, after all, first in his mind, and to which before long he gave himself exclusively

Just forty years ago, in the year 1883, opportunity came to him in the form of a call to the city of Columbus as manager of the gas works In the meantime his intensive study of chemistry, physics and other branches of science relating to the manufacture of gas had been fruitful in the invention of a method of purification which materially affected both quantity and quality of the product For many years the people of Columbus had been paying an exorbitant price for an inferior quality of illuminating gas and at last relief was sought in a change in the management of the works

Mr McMillin was chosen as manager at the then unusually high salary of four thousand dollars a year In a comparatively short time the president of the Gas Company declared that the salary of the manager was being paid out of the economies which he had introduced which, together with a greatly reduced cost of production due to the use of scientific methods, made it also possible to reduce the price to consumers

He devoted five or six years to the development of the Columbus plant, all being done in harmony with one definite plan which may be said to furnish the key to his great success, namely, to supply the best possible product at the lowest possible cost to the consumer, on the principle that the interests of the producer and the consumer were one In a few years he was not only the manager but also practically the owner of the Columbus gas works and there came visions of larger operations in engineering finance

His next step was perhaps the most important in all his career, for because of its magnitude and success he became at once a national figure in the field of industrial management

The city of St Louis had been cursed for some years by the existence of four competing and continually warring gas companies, both consumers and stockholders being the victims of unscientific and irrational methods of doing business In this situation Mr McMillin saw an opportunity for bringing about a consolidation of interests which would greatly benefit all parties legitimately concerned His success at Columbus was a sufficient guarantee to win for him the support of some bankers in New York City and after overcoming many difficulties, the four organizations were amalgamated into the Laclede Gas Company

Of the many phases of this operation, there was one of sufficient interest to justify special mention at this time and in this place The successful achievement of the result depended on certain agreements with the city government regarding franchise It must be regretfully admitted that forty years ago the code of morals in legislative bodies, especially in municipalities, was of a distinctly lower plane than even at the present time Among a certain class of office holders, receiving pay for votes in awarding contracts or granting franchises, was regarded as a perfectly natural proceeding and a practice the existence of which was generally known Heavy demands of this nature were made upon Mr McMillin, and one small group, believed to be sufficiently powerful to determine the result, notified him that nothing less than twenty-five thousand dollars would secure the legislation necessary to accomplish the end he had in view

Not long after this ultimatum had been issued I happened to be in St Louis for a day and accidentally met Mr McMillin The question had been settled, the victory was his and sitting together at luncheon he gave a most vivid and entertaining account of his battle with the spoilsmen

"I have millions," he told them, "for development and improvement, but not one dollar or one cent for tribute" He made them understand that he would sacrifice all that had already gone into the enterprise rather than yield an inch The yielding came from the other side and was complete, though probably accompanied by great astonishment at Mr McMillin's attitude which was doubtless a novel one to the city officials Evidently they concluded that a man who would not buy could not be bought and from that time the mutual relations of the municipality and the new company were established upon that basis

The success of this, his first very large venture in the field of public utility reorganization was so great that he immediately gained the confidence of conservative and influential financiers and capital, practically unlimited in amount, was available for similar enterprises, a number of which he undertook and successfully completed

Unquestionably his success was largely, and in the beginning mostly due to the "five hours every day" devoted, during a period of twenty-five years to the intensive study of the "sciences that were useful" to him During these years he had not only acquired knowledge, but his naturally keen intellectual faculties had been brought to a high state of discipline, ready to attack with vigor and usually with success, any new problem which might present itself

Up to the year 1801 he had been generally serving others, organizing and executing projects of which, though inspired by him, he did not have complete control In that year, however, he resigned from a very lucrative position to enter the business and financial world on his own account Associated with him in this venture was Col Henry B Wilson of Ironton, (brother of the late Col E S Wilson, editor of the "Ohio State Journal") with whom he established in Wall Street, New York City, the banking house of Emerson McMillin and Company

This took him more completely into the field of finance and the promotion of public utilities, thus practically terminating the period during which he personally managed the enterprises which he controlled But it cannot be without interest to the group of men for whom, primarily, this sketch has been prepared, to note that behind McMillin, the financier, was always McMillin, the engineer The success of the firm of Emerson McMillin and Company was immediate and great, for in all of its undertakings it was guided by the engineer's instinct and the engineer's caution

To the purchase and reorganization of gas producing plants there was soon added the acquisition of electric light and traction properties The operations of the firm were co-extensive with the United States and at one time it controlled more than forty such corporations, including those of many of the principal cities In 1901 these were combined into one giant corporation, the American Light and Traction Company, with a capital of over forty millions of dollars and Emerson McMillin as president

Later in life he gradually disposed of a majority of these properties but at the time of his death he controlled seventeen of them, including a number of the largest and most important, and he continued to the end, to take an active and keen interest in the affairs of his house, presiding at a meeting of the executive committee only a few days before his death

It would be interesting and instructive to consider in some detail a few of the more extensive operations in which he was engaged, but I confine myself to one or two of the most difficult and most important, illustrating those qualities which insured the success of his undertakings

It was he who organized the company for the construction of the tunnel under the East River, connecting Long Island and New York City At the beginning of this great enterprise and up to the day of the formal opening of the tunnel many able engineers pronounced it an impossible achievement Great difficulties were encountered during the construction period, stockholders were discouraged and disheartened but the work was guided by one who had not known failure and whose efforts were again rewarded with success

Mr McMillin was one of the first to appreciate the tremendous potential value of the Welsbach non-combustible mantle for incandescent gas-lighting and he had a large financial as well as a scientific interest in its development and practical use in this country

Because this process greatly reduced the quantity of gas consumed per candle power of illumination many gas producers were actively opposed to it, but McMillin had achieved distinction as a gas engineer upon the sound economic policy that by diminishing the cost and at the same time improving the quality of a commodity in general use a greatly increased demand for it would be created Better light and cheaper light would mean more light and in spite of long and discouraging delays in the perfection of the process the soundness of his judgment was established on the pages of his ledger

But in the meantime, along with the rapid development of his business enterprises there was an equally rapid and even more notable development, growth and evolution in the man himself As Col E S Wilson once said of him, "McMillin grew faster than his wealth "

The five hours of intensive study each day, devoted, during many years to the various branches of science which were contributory to the solution of engineering problems incident to his extensive undertakings, were subsequently spent upon Art, Music, History, Political and Social Science, Foreign Languages, etc , "always systematically," and their cultural effects were strikingly noticeable There was nothing superficial about his knowledge and accomplishments, and it is, therefore, not so strange that the youthful charcoal burner, who studied the heavens while standing guard at a military post in time of war, became a devoted student of art and a collector with a discriminating sense of values rarely excelled

It is common to divide "money-getters" into two classes those who desire wealth as a means, and those who seek it for its own sake I think Mr McMillin belonged to neither of these groups His pleasure, his real joy, was in doing the job, in beating down the obstacles that rose in his path, and on such men Fortune rarely fails to smile

To one to whom wealth comes in this way the problem of making good use of it generally receives serious consideration and it often proves to be a most difficult one Mr McMillin's gifts of money for the relief of the unfortunate, for civic or educational projects, were numerous and large and in a great many instances individuals who profited by his generosity never knew the source of the help which came to them In addition to giving money he gave much valuable time, being never too busy to give careful consideration to the claims of any cause which promised to be fruitful

At an early period of his residence in New York city he came to be recognized not only as a master of finance but as a man whose interests were broad and liberal and he was soon a member of numerous organizations of a public character having for their object the public good

He was greatly interested in World Problems, being a member of the "Committee of One Hundred" which had for its object the establishment of a "True International Court of Justice" and he was one of the principal organizers of the "World Court League" Shortly before his death he accepted the presidency of the Arbitration Society of America

Throughout his whole life Mr McMillin gave freely of his resources to the aid of suffering humanity, though because of his modesty and reluctance to speak of his own work, the full extent of his generosity will never be known During a period of at least forty years he employed agents to investigate and report upon cases which appealed to him and his distribution of charity was made with the same careful discrimination that had guided him in business

In our war with Spain, Mr McMillin, past the age of actual military service, was represented by his son, Marion, who bore the name of one of the three McMillin brothers who gave their lives in the Civil War He also gave generously of his wealth, especially in making provision for the wives and children of soldiers, purchasing a farm in West Chester County, New York, and founding a home for that purpose

After the close of the war he converted this plant into a "Vacation Home for Factory Girls" which he maintained for many years entirely at his own expense

At the beginning of the recent great war and before the United States had entered it, Mr McMillin was a large contributor to the financial support of Italy, for which country he had formed an attachment during a visit of some length a dozen years earlier This friendly interest received a graceful and generous recognition on the part of King Victor Emanuel It is unnecessary to say that when his own country became one of the participants in the great conflict he was an earnest and efficeint supporter of the government in all of its efforts to insure victory

In actual military service the family was again represented by Captain Marion McMillin who served throughout the war

Mr McMillin was a member of many clubs and societies, forty or fifty in all, though he would hardly be called a "clubbable" man Though fond of his friends and generous in hospitality there was not much room in his life for frivolous conversation or unimportant commonplace

For his recreation he sought the open, he had an intense love for the forest, possibly a heritage of his boyhood, and he was a hunter of both big and little game

His lifetime interest in astronomy led him to erect and equip an astronomical observatory for the Ohio State University, known as the Emerson McMillin Observatory, which, in the hands of its able Director, Professor Henry C Lord, has been the means of making numerous important contributions to the science of astronomy To this generous gift he added the endowment of a Fellowship in Astronomy, for a period of five years, and he made further gifts of money from time to time, for the purpose of enabling the Director of the Observatory to attend important conventions, also financing completely an astronomical expedition to the Hawaiian Islands, for the purpose of observing the effect, if any, upon the solar spectrum, of the transit of Halley's comet across the disk of the sun in 1910

The University is indebted to him for other important gifts, including several thousand dollars for the purchase of books for the Law Library and also a sum of money which made possible the acquisition by the Geological Museum of the only complete skeleton of the Megalonyx in existence

Mr McMillin was one of the first to show an active interest in the development of aeronautics, contributing in money nearly forty thousand dollars for the investigation of aviation problems, and he also offered to pay the cost of training two hundred pilots

Much other evidence might be given of his readiness to contribute to "the increase and diffusion of knowledge among men," as well as innumerable instances of his generous aid to the distressed and unfortunate Never forgetting the limitations of his own boyhood he had more than a mere responsive interest in the ambitions of young people to secure the benefits of an education and, in a large and systematic way he undertook to assist them, though the source of the aid thus rendered was seldom known by the beneficiaries

Out of a considerable number of experiments in this field of philanthropic endeavor it is not strange that there were some failures Among those who were directly helped by gifts of money, results were so unsatisfactory as to produce a definite and decided opinion that to attempt to create a career for a young person by an outright gift of money was illogical and doomed to failure

This lesson was undoubtedly a bitter one but as Mr McMillin's experience is worthy of the careful consideration of all who are concerned with the education of young people I think I am justified in giving a brief resume of it, as it came to me in his own words a few years ago

> "During a period of about ten years, beginning with the year 1900, I helped twenty-five persons to obtain the kind of an education they most desired They were practically supported by me for one, two, or three years, were mostly girls and the greatest number of them were educated for teachers, many for music During this time there were about twenty-five boys with our companies who evinced an interest in the sciences They were given opportunities to develop, to use the scientific libraries and laboratories
>
> "RESULT All those helped financially were failures All those given opportunity to help themselves were successes, and are now drawing salaries of from $5,000 to $25,000 per annum "

This statement certainly presents a gloomy outlook for the advocates of free tuition and heavily endowed scholarships, and it may be urged, perhaps with justice, that Mr McMillin has made use of a false unit in evaluating success

But it was probably true that every one of those educated at his expense had definitely in view the acquisition of knowledge and skill for the purpose of earning money It is also true that "salary" is a much better measure of success than income from business, investments or inheritance, because it is an evaluation by others, whose interest is to minimize rather than exaggerate

Mr McMillin's connection with the Ohio Academy of Science began twenty-five years ago

At the meeting in December, 1898 "Professor Lazenby reported that Emerson McMillin had given $250 00 to the trustees of the Academy to be expended in such ways as they thought best suited to promote scientific research, and had said that such a sum might be given annually, provided the use made of the money were satisfactory and it proved to be convenient for the donor to spare it " In order to provide for the administration of such a fund Professor Lazenby offered an amendment to the Constitution of the Academy, establishing a Board of Trustees, consisting of three members to be chosen as at present, but as this could not be acted upon before the next annual meeting the Academy voted to accept the gift and a temporary board was chosen to administer the fund for a single year

This board consisted of F M Webster, W R Lazenby and E L Moseley The first Board of Trustees elected under the amended constitution consisted of F M Webster, H C Beardsley and J H Schaffner

In a communication from Mr McMillin a year or two later he expressed a preference for the use of the fund as a direct subsidy or gift "to entirely competent and experienced investigators, not otherwise provided with financial support," rather than for printing or publication, adding, however, that he did not wish to dictate in any way as to the use of the gift

For a number of years annual statements of the expenditure of the fund were submitted to him, and in some instances his opinion was asked as to the wisdom of making grants for certain kinds of research In all cases his response was such as to indicate a desire not to interfere with or influence the policy of the trustees

It is interesting to note, however, that he did, in one of his letters express himself as rather strongly opposed to allowing his annual gift to accumulate in order to form a permanent fund Though declaring that the Academy could do as it liked, he added, "On general principles I am opposed to permanent funds The future will be able to take care of itself It is much easier now than it was a generation ago to secure funds for this work, and it will be much easier a generation hence than it is now " During the bond-buying period of the late war I wrote him of the investment of $500 00 of the fund in a Liberty bond which met with his cordial approval

In nearly every one of his letters to the Trustees or the Secretary of the Academy, he speaks of his strong desire to attend its meetings, but as far as I know, he was never present at one of them There were, however, frequent expressions of great interest in it and its work At my request a few years ago, our associate, Dr Herbert Osborn, prepared a list of published contributions to science which had been made possible in a large measure through his annual gift This was sent to him and upon it he remarked

> "The research fund seems to have been pretty lively and doing work out of proportion to its size The workers rather than the cash, probably are entitled to the credit "

At another time he wrote

> "The Academy needs to live centuries I cannot, at most, live but a few years, much as I would like to be permanently established at Darlington "

The last meeting of the Academy happened to occur on the days just preceding the seventy-eighth anniversary of Mr McMillin's birth and the Committee on Resolutions reported a congratulatory message which was telegraphed to him by our Secretary, as follows

> "The Ohio Academy of Science in its thirty-second annual meeting in Columbus desires to extend to you on the occasion of your seventy-eighth birthday its heartiest congratulations, and wishes to express to you its appreciation of your continued support of scientific research through the Academy "

In reply to this we have his last message to us, as his death occurred a few weeks later It is addressed to Edward L Rice, Secretary, and reads as follows

DARLINGTON, MAHWAH, N J, April 18, 1922

"DEAR MR SECRETARY

"Your telegram conveying the birthday greetings of the Ohio Academy of Science was received on time, and was the best tonic I have received during the last fifteen months of almost constant illness

"I do thank you and the Academy most sincerely,

"EMERSON MCMILLIN "

OBSERVATIONS ON THE SEXUAL STATE OF VARIOUS PLANTS [*]

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In recent years the writer has accumulated a considerable number of records of experiments and observations on various phases of the sexual state of plants which, although hardly extensive enough for special treatment, are nevertheless of importance in leading to a correct understanding of the nature of sexuality in the sporophytes of the higher plants A number of the more important observations are, therefore, presented below which may give additional support to some important conclusions previously reached and published from time to time

ACNIDA TAMARISCINA (Nutt) Wood

Experiments have been conducted on this diecious plant in the hope that a method for producing sex reversal might be discovered which would prove as effective as the methods used with the hemp, hop, and Arisæma So far the effort has been only partially successful, only a few intermediates having been produced The species is a very abundant weed in the cultivated fields of North Central Kansas where extensive observations were made in the field to determine its normal sexual expression It seems to be normally strictly diecious The typical staminate flower has five sepals and five stamens, while the carpellate flower has an ovulary with three prominent stigmas The carpellate flower is described as wanting a calyx but the two minute bracts situated immediately beneath the ovulary may just as well be regarded as a reduced calyx (Fig 1a) In either case the vegetative parts of the flower are strongly dimorphic There are no vestiges of stamens in the carpellate flower but the staminate flower has a small vestigial gynecium without stigmas (Fig 1b)

One carpellate intermediate plant had a large number of normal carpellate flowers in a simple spike-like inflorescence but in the middle of the inflorescence a single bisporangiate flower developed which had an ovulary with two sigmas and beside this a perfect stamen bearing pollen (Fig 1c) There was thus sex reversal in only one little group of cells in this entire plant which managed to develop a perfect stamen All the remaining part of the inflorescence remained in the female state

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[*] Papers from the Department of Botany, The Ohio State University, No 140

One staminate intermediate plant produced a flower in the leaf axil of the second leaf that had an ovulary-stamen complex with fairly well-developed stigmas (Fig 1d) The remaining flowers were pure staminate

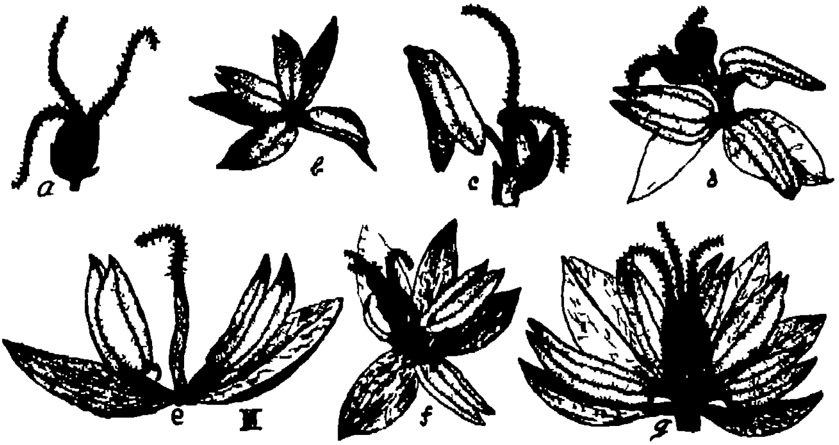

FIGURE 1

Fig 1 Flowers of Acnida tamariscina (Nutt) Wood a—Typical carpellate flower from carpellate plant showing the three stigmas, the ovulary and the two perianth bracts or sepals below b—A young staminate flower from a staminate plant showing the sepals stamens, and vestigial ovulary in the center This flower is abnormal in having only 4 stamens and 4 sepals instead of 5 c—Bisporangiate flower from a carpellate plant This flower was in the middle of a rather long carpellate inflorescence The perfect stamen was the only staminate structure developed on the entire plant all the other flowers having pure female expression d—Abnormal intermediate flower from a staminate plant with slight expression of femaleness Three sepals have been cut away None of the 3 stamens are normal in appearance The one in the stamen-carpel complex has two long microsporangia and one short one The ovulary is only slightly developed but has three short stigmas and on one side a small neutral microsporangium e, f, g—Flowers from an intermediate plant which had all the flowers more or less bisporangiate The plant was probably a modified staminate plant The flower represented by e had a rudimentary ovulary ending in a single stigma, 5 normal stamens and 5 normal sepals f—Flower with 4 sepals, 2 normal stamens, and a fairly well developed gynecium with 3 stigmas On the upper part of the ovulary wall, at one side, is a sessile anther with 2 microsporangia g—Bisporangiate flower with 5 normal sepals 5 normal stamens, and a nearly perfect gynecium with 3 stigmas

Another staminate intermediate plant had numerous bisporangiate flowers and a number of pure staminate flowers (Figs 1e, f, g) This intermediate plant had part of its flowers as follows

1 A flower with 6 stamens and 6 sepals

2 A flower with 5 stamens, an ovulary with 3 stigmas, and 5 sepals

3 A flower with a distorted ovulary with 3 stigmas and a small anther of 2 microsporangia on its side at the top, and with 2 stamens and 4 sepals

4 A flower with 4 stamens, an ovulary with 3 stigmas, and 5 sepals

5 A staminate flower with 4 sepals and 4 stamens

6 A staminate flower with 5 sepals and 5 stamens

7 A flower with 5 sepals, 5 stamens, and a prominent vestigial ovulary with one stigma

8 A flower with an ovulary with 3 stigmas, 5 stamens, and 5 sepals

9 A flower with an ovulary with 5 stigmas, 2 stamens, and 5 sepals

10 A flower with an ovulary with 3 stigmas, 3 stamens and 4 sepals

11 A flower with an ovulary with 4 stigmas, 4 stamens and 4 sepals

12 A flower with an ovulary with 4 stigmas, 3 stamens and 5 sepals

The disturbance in the sexual state, caused a great confusion in the morphological expression of the flower not unlike that which occurs in the winter hemp plants, although as will be noted from the above catalog there seems to be a tendency to produce the parts in fives

It will be seen, therefore, that although the writer has not yet discovered the proper environment for inducing considerable sex reversal in Acnida tamariscina, the short daylight period of December has apparently caused a minute percentage of reversal and this reversal is in both directions, the staminate condition to the carpellate and the carpellate to the staminate The sexual dimorphism present was, therefore, not due to special homozygous or heterozygous sex factors, for if such had been the case reversal could at the most have taken place only in one direction Furthermore, it is not at all a case of abnormal chromosome complex because in that event all the flowers on a plant should have been effected somewhat similarly The conclusion is plain that the dieciousness of Acnida is like that of the hemp caused by a reversible sexual state, any given state established at the beginning of the ontogeny being quite fixed within a certain range of environmental factors

In Figure 1 are presented drawings of normal and intermediate flowers which will show some of the diversity of morphological expression when the sexual state has been altered in the vegetative tissues of the individual

THALICTRUM DASYCARPUM Fisch & Lall

In the field Thalictrum dasycarpum consists in any given season of pure carpellate plants, pure staminate plants, and a large percentage of intermediates, grading from plants which have about an equal number of staminate and capellate elements to the two extremes where a carpellate plant may have a solitary stamen and a staminate plant a single carpel, among a profusion of normal flowers The writer asked himself the question whether the different categories of plants, pure carpellates, pure staminates, and the individuals of the various degrees of male and female expression, are fixed in their sexual nature and whether this sexual nature is due to an hereditary complex in the cells of the individual that controls the sexual expression

A pure staminate plant and a pure carpellate plant were transferred in 1920 from a rich moist habitat to a rather dry clayey soil on the north side of the greenhouse and given no further attention except an occasional watering In 1921, the staminate plant had some carpels The carpellate plant was accidentally broken off at the top and did not bloom In 1922, the staminate plant had numerous carpels and also some entirely carpellate flowers, and the carpellate plant had numerous stamens and also some flowers entirely staminate The originally carpellate plant was decidedly more staminate the second year than carpellate

From this simple experiment it is, therefore, plain that our notion of the fixity of the sexual state is quite wrong and that the nature of the plant may change from year to year The cause of the different grades of sexual expression is not to be found in a study of specific hereditary constitutions What makes a plant pure carpellate, pure staminate, or intermediate in sexual expression in any given year or period of years is not due to any heredity compelling maleness, femaleness, or intermediateness, but is due to the fact that the heredity is of such a nature in the species as to permit the sexual expression to vary with the environment As one finds the various types of individuals in the field, one knows that the different types must all have the same hereditary constitution which is of such a nature as to allow the sexual state to be easily changed, and the probability of an individual remaining of the same type for any length of time in a changing environment is remote Thalictrum dasycarpum is, therefore, in strong contrast in respect to its sexual nature with a diecious species like Acnida tamariscina in which a given sexual state once established is apparently not easily changed

ACER SACCHARINUM L

The silver maple is a diecious species which shows intermediate individuals of varying degrees of staminateness and carpellateness and frequent reversals of the sexual state in its branches in both staminate and carpellate individuals Often there are typical staminate flowers showing normal stamens and reduced gynecia on prevailingly carpellate plants side by side with typical carpellate flowers Mingled with these there may be various types of intermediate flowers as follows carpellate flower with one fruitful stamen with the other stamens reduced, carpellate flower with two fruitful stamens and the remaining ones reduced, carpellate flower with three fruitful stamens and the remaining ones reduced, flower with a normal gynecium and all the stamens enlarged and fruitful, or a completely bisporangiate flower

Sometimes a branch on a staminate tree changes from completely staminate below to completely carpellate above with various types of more or less perfectly bisporangiate flowers on the transition zone Branches have been found on a carpellate tree that were first carpellate, i e , had short side branches or clusters with normal carpellate flowers, and then continued with a zone, a foot or so long, with all the flowers typically staminate, and finally by another reversal became carpellate again toward the outer end In such cases there must be either a double reversal of the sexual state itself or of some more primary condition leading up to the perfected sexual state Femaleness is expressed for a time in the branch and further on maleness and still farther up the branch femaleness again becomes established

Some trees are apparently entirely staminate or entirely carpellate at least for the season Occasionally a tree has only a trace of the flowers of the opposite sexual state, while some appear to be about equally staminate and carpellate Such trees may be considered to have a neutral meristem in the same condition in regard to sex as that in ordinary monecious species or species with bisporangiate flowers, while those trees that are decidedly or completely staminate or carpellate in expression may be supposed to have a physiological state already established in the meristem which under ordinary conditions invariably leads to a certain sexual expression or which under a changed environment reverses to an opposite condition leading on to the opposite sexual state

A remarkable condition is presented by plants of the maple type of sexuality in that when the sex is reversed the conditions of development become the same as those present in trees of the opposite sexual state A flower which has been completely reversed from the staminate condition not only has the ovulary normally developed but its stamens are reduced to vestiges although it is borne on a staminate tree, and in the same way a staminate flower on a carpellate tree has a vestigial ovulary This peculiar phenomenon is probably not due in these cases to the diffusion of hormones from cell to cell but rather to reversals in cells or groups of cells at a given stage in the ontogeny The vestigial structures may for a short time be in a preliminary stage leading to a given sexual state and later this state fades out in the incept to a neutral state or is even reversed to the opposite sexual state which inhibits any further development in the given line

A sex limited character was observed in a staminate tree with some carpellate branches and some partly carpellate branches which showed the complexity of the sexual states and sexual expressions to be analyzed and interpreted Both the normal staminate flowers and the reversed carpellate flowers had red anthers, the latter of course being vestigial, while the stigmas of the carpellate flowers were long and red and the vestigial stigmas of the staminate flowers were short and green

ACER RUBRUM L

The red maple is a diecious tree which seems to have less sex reversal than the silver maple Nevertheless, it is not difficult to find staminate trees with well-developed carpellate flowers and carpellate trees with perfectly developed staminate flowers, each with its appropriate vestigial structures The writer has found a number of such trees The diverse nature of the sexual expression shows, as in the silver maple, that the sexual characters are not at all due to any special sexual hereditary complex of chromosomes or factors but to reversible states set up at various points in the tree which already had a distinctive trend toward a single sexual state Segregation and aggregation of chromosomes are not involved in the sex determination or reversal

THALICTRUM DIOICUM L

This species of meadow-rue is rather strictly diecious Search has been made for two seasons for intermediate individuals and five have thus far been found after a search of several hours It is to be inferred that a small percentage of intermediate plants is produced at each blooming season The intermediate plants were as follows 1 A staminate plant with a single flower which had a peculiar stamen-carpel complex with a well-developed stigma The remaining flowers were all of the normal staminate type except one which had a marginal structure half stamen and half sepal 2 A plant exactly intermediate in sexual expression All the flowers on this plant were bisporangiate, the carpels being mostly in the center and the stamens at the outer margin 3 A carpellate plant with several flowers having one or more imperfect stamens 4 A carpellate plant with a number of typical staminate flowers and some bisporangiate flowers 5 A carpellate plant much like No 4, but with fewer staminate flowers

Two carpellate plants which showed some stamens were dug up in the spring of 1922, planted in pots in the greenhouse, and well fertilized with cow manure One died but the other grew well and bloomed in September, again developing some stamens along with numerous carpellate flowers In November the plant bloomed again, showing the same confusion of sexuality, but at the third period of blooming in January, 1923, only carpellate flowers were produced So this individual may also appear as a pure carpellate from time to time although it has shown its potentiality to be bisporangiate at times *

These few plants show that the sexual state in Thalictrum dioicum ranges all the way from decidedly intermediate plants with bisporangiate flowers through every conceivable degree to strictly monosporangiate individuals The condition is essentially the same as in Thalictrum dascycarpum with this important difference, however, that while sex reversal is very easily brought about in the latter species and there are thus always abundant intermediates present, in Thalictrum dioicum the sexual state is strongly fixed in the plant's normal environment and intermediates are quite rare There is again no question but that sex reversal takes place in both directions, maleness to femaleness and femaleness to maleness As is well known there are species of Thalictrum with normally bisporangiate flowers, and from this primitive condition a series of species are known grading from the irregular monecious type through dieciousness with numerous intermediates to dieciousness in which the intermediate condition is very rare Such examples show that the attempt to explain sexual states by a simple Mendelian formula of homozygous and heterozygous hereditary constitutions falls entirely beside the mark

AESCULUS GLABRA Willd

The Ohio buckeye is a monecious species with staminate and carpellate flowers commingled in the same inflorescence Both flowers have prominent vestiges of the opposite set of sporophylls There are also flowers that are intermediate between the two extremes, apparently of the normal bisporangiate type The petals of the staminate flowers are more yellowsih in color than those of the carpellate flowers which have a decidedly greenish tinge and are much less open These secondary sexual characters sometimes become quite prominent en masse when entire panicles are staminate or nearly entire panicles carpellate

Individual trees were studied and it is evident that they grade all the way from purely staminate (observed in young plants only) to decidedly carpellate individuals No pure carpellate plants have been observed but some have been found to have a very much larger percentage of carpellate flowers than

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*At the end of this plant bloomed again with all the flowers carpellate staminate Three trees were especially studied because of their apparently extreme staminateness Some of their panicles were entirely staminate and some had a single carpellate flower, others had two or more carpellate flowers with well-developed gynecia A young tree, as stated above, probably in its first or second blooming season was found to be purely staminate in sexual expression Such pure or decidedly staminate trees can sometimes be discovered through the bright appearance of their flower clusters In this young tree the flower clusters were compact and very showy with bright yellow petals, because of the extreme condition of the male state

It is possible that the sexual state changes from time to time because of changing environment or the progress of senility, but no definite observations have been made along this line except that some trees appear to be much more fruitful in some years than in others, which might, of course, be due to other causes than the relative amount or degree of maleness or femaleness expressed for the giving seasons From these observations, the buckeye tree is found to be a monecious species which has individuals ranging, in any given year, in sexual expression, from pure staminate to decidedly carpellate This range of the sexual condition from pure staminate to decidedly carpellate but not to the complete carpellate condition recalls a somewhat similar state of affairs in Arisæma dracontium (L) Schott

GENERAL DISCUSSION

Although the careful study of the sexual states of monecious and diecious trees is attended with some difficulty, such studies would assist materially to a correct understanding of the nature of sex and the way in which the sexual state is developed in the individual or a part of the individual The higher conifers would apparently also be an especially fruitful region for study as well as the interesting order of Sapindales to which buckeyes and maples belong

The study of monecious and diecious species has shown that moneciousness and diecousness are but extremes of a common series of sexual phenomena and are of varying degrees of intensity and extent The intensity of the sexual state is independent of the monecious or diecious condition In either state a species may be decidedly constant or decidedly unstable The diecious species may have the given sexual state so slightly developed that even under the ordinary environment reversals take place quite frequently, the states may be so fixed that reversals occur only in the presence of unusual ecological conditions, or they may be so intensely developed that so far no intermediates are known to have been produced, either in the natural environment or when the plant is growing under extremely different ecological conditions Similarly, monecious species may be so constituted that there is little variation between individuals in respect to their sexual expression or they may have the given neutral or sexual state so slightly established in the cells of the individual, that determinations or reversals do not follow any very regular course in the ontogenetic development, in consequence of which the type of expression varies decidedly from one individual to the next The lowest type of monecious species is that in which the one or the other sexual state is established permanently at the base of the floral axis, resulting in monosporangiate flowers In the more extreme types, the time of determination of the sexual state is shifted back to an earlier axis thus producing entire inflorescences with one type of flower or entire branching systems involving numerous inflorescences or even considerable parts of the vegetative structures Besides these there is the very common type in which sex reversal takes place at a given level or zone in the inflorescence itself simulating the sexual zonation to be observed in the ordinary bisporangiate flower

The diecious condition is presumably brought about by the establishment of an hereditary constitution in which sex determination is coincident with fertilization in the ordinary environment in which the species lives This shifting of the time of determination has nothing to do with the relative intensity or permanence of the sexual state set up, for as the writer has ascertained, both from observation and experiment, sex reversal and changes in the sexual state can be brought about as easily, if not more so, in the diecious sporophyte individual as in the monecious If the sex is determined or reversed at the time of fertilization, i e, at the time of the fusion of the male and female nuclei, the cause and the mode of determination must, nevertheless, be fundamentally the same as when the determination or reversal takes place in the vegetative incept of the flower bud or sporophyll *Before we could assume that a new functional activity, a new chemistry or physics, was at work, we would need some very strong evidence for the assumption This observation applies to unisexual individuals with allosomes as well as to those without*

Bisporangiateness, moneciousness, and deciousness, therefore, fall into a progressive series of many stages in respect to the intensity and fixity of the sexual state, all depending on a fundamentally similar physiological activity, the more prominent stages being as follows

1 Typical bisporangiate species

2 Bisporangiate species with the development of some monosporangiate flowers, either staminate or carpellate, or both

3 Monecious species with some bisporangiate flowers

4 Monecious species normally without bisporangiate flowers

5 Monecious species which produce individuals of a greater or less degree of staminateness or carpellateness in the individual, together with occasional individuals purely staminate or purely carpellate or with both these types occasionally present

6 Diecious species with numerous intermediates of all degrees and with sex reversal easily accomplished

7 Diecious species with few intermediates and with apparently little sex reversal

8 (?) Diecious species with no intermediates and no sex reversal at least under normal conditions

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SOME CONFUSED SPECIES OF PHLEPSIUS AND EUTETTIX (HOMOPTERA)

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PHLEPSIUS STROBI Fitch

Bythoscopus strobi Fitch, Fourth Report, N Y State Lab N H p 58, (1851)

This species was described by Fitch, as taken from Pine, but Van Duzee and later authors have applied the name to a species of Eutettix which is strikingly like it in general appearance but which occurs on *Chenopodium* The Fitch description reads

"PINE BYTHOSCOPUS, *B strobi* Yellowish-brown, elytra with three white bands, and closely inscribed with fuscous points and lines outer margin with small fuscous spots, beneath brown, legs pallid with spine-bearing black dots Length 0 20 Common on pines in May No 771, male, 772 female " (Vide reprint in 46th Rept State Museum, N Y , 1893)

While very brief this applies perfectly to a small species of *Phlepsius* that I have taken from Pine in Ohio and to specimens received from collectors in New York and, what is most important, the specimens from pine agree perfectly with the specimen from the Fitch collection in the National Museum A more detailed description follows

Resembling *Eutettix chenopodii* but with longer, angular edged vertex and with three whitish bands on elytra, the anterior one extending from scutellum to half way point on clavus Length, female, 4 5–5 mm , male, 4 1 mm

Head wider than pronotum, vertex angular, one-half longer at middle than next the eye, margin angular, front longer than wide, clypeus with sides nearly parallel apex truncate, loræ nearly touching margin of cheek Pronotum twice as long as vertex, hind border slightly emarginate

Color gray fulvus Vertex fulvus mottled with whitish and with pronotum and scutellum brown, irrorate with gray or whitish, elytra with bands of white and brown, a white band across base from middle of scutellum to middle of clavus, another just beyond apex of clavus and a third just before the apex, are inscribed with delicate brown lines

Genitalia Female last ventral segment long with median third produced Male valve short, rounded behind, plates triangular, tips acute

Specimens have been taken at Cantwell Cliff, Ohio, on Pine, in Guernsey Co , Ohio, by Mr F E Guyton, and I have examined specimens from Yaphank, L I , N Y , collected May 30, 1911, by Mr Chris E Olsen

PHLEPSIUS UHLERI, Van Duzee

Similar to *P strobi* Fitch in size and coloration but with the vertex less angular, horizontal and distinctly transversely depressed while the pattern on the elytra differs in that the middle white band is angular and more broken, and the white spots clearer and more sharply defined

The specimen in the National Museum, presumably one from which the description was written is labeled "Odenton Aug 1" and "Phlepsius uhleri V Duz Md "

The Van Duzee description is good and the above comparison will suffice to separate the species from *strobi* Fitch (not Van Duzee) to which it seems most closely related From *lippulus* it differs in the shorter vertex as well as somewhat smaller size and especially in the male genitalia While in the same group as *franconiana*, *slossoni*, *fastuosus* and *punctiscriptus* it is much smaller than any of these and has decidedly different genitalia

EUTETTIX CHENOPODII *n* sp

Phlepsius strobi Van Duzee Trans Am Ent Soc XIX, p 67, 1892
Eutettix strobi Ball Pr Dav Acad Sci XIII, p 44, 1907
Eutettix strobi Van Duzee Catalogue p 665 1916

Similar to *Phlepsius strobi* Fitch, but with the vertex short, rounded to front and the elytral picture consisting of two whitish bands instead of three Length, female, 5 5, male 4 5

Head slightly wider than pronotum, vertex short rounded in front with a shallow transverse depression, scarcely longer at middle than next the eye, obtusely angulate to front, front slightly longer than broad clypeus short, scarcely widened at tip, loræ elongate, the tip reaching border of cheek Pronotum more than twice as long as vertex, hind border concave

Color, light fulvus irrorate with light yellow or whitish Elytra brown, with two white bands, the forward one oblique and extending from tip of scutellum to costa at middle, the hinder one crossing the ante-apical cells

Genitalia Female last ventral segment twice as long as preceding, hind border rounded with a notched lobe at the middle Male valve rounded behind, plates triangular, tips acute

This is a common species throughout the eastern U S and its nymph is found on Lambs quarter (*Chenopodium*) where it produces purple spots that agree in color with the nymph The description is from specimens collected in Iowa and Ohio, but records under the name of *strobi* carry its distribution from Maine to Utah and south to North Carolina and Texas

The nomenclature of this species presents a peculiar puzzle as it was actually described by Van Duzee under the name *strobi* which as shown above, must apply to a different species and the name would be preoccupied in *Phlepsius* Ball, however, described the species having placed it in *Eutettix* in which genus the name *strobi* has not been used for any other species However this was simply a transfer of the Van Duzee misnomer and as the species occurs on *Chenopodium* and not on *Strobus* it will avoid confusion to give it a new name and preferably one which indicates its restricted food habit

Type and paratype specimens of above description in author's collection

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THE COMPARATIVE PARASITIZATION OF CERTAIN FRESH WATER SNAILS*

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INTRODUCTION

This problem was begun at the Lake Laboratory in July, 1921 and continued in the Autumn and Winter of the same year at Ohio State University It is essentially a comparative study of the parasites of certain fresh-water snails The area from which snails were collected during the month of July was the region of the Bass Islands of Lake Erie In order to compare conditions there with those of a stream that part of the Olentangy River which runs through the property of the Ohio State University, was the place of collection in October and November

While from the nature of the case some systematic work was necessary, the primary purpose of this study was bionomic To determine the following, have been the aims of this investigation

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*A thesis submitted in partial fulfillment of the requirment for the degree of Master of Science at Ohio State University

First, the species of fresh-water snails parasitized by larval trematodes,

Second, the identity of the trematode parasites,

Third, the approximate degree of parasitization in each case of infection,

Fourth, the percentage of parasitization within each species,

Fifth, the incidence of larval trematode infection among fresh-water snails

The work was undertaken at the suggestion of Professor F H Krecker Aside from his helpful suggestions I am indebted to Mr Bryant Walker, of Detroit, for the identification of the snails, to a fellow student, Mr James Davis, for a translation from the French of Dollfus' description of Cercaria pachycerca, and to the following for their previous studies on North American larval trematodes Professors W W Cort, Johns-Hopkins University, E C Faust, Parasitologist, Union Medical College, Peking, and E C O'Roke, South Dakota State College The literature on trematodes is cited, for no true internal parasites were found other than these

HISTORICAL ACCOUNT

"Among the early American Zoologists, Joseph Leidy alone was a student of Cercariæ "*[10]

In 1914, when W W Cort wrote his preliminary report "Larval Trematodes from North American Fresh Water Snails," [4], he found eleven previous references, in North American scientific literature, to larval trematodes In the last mentioned paper and in the monograph of 1915 "Some North American Larval Trematodes," [5] Cort described fourteen new species of Cercaria The snails examined by Cort were from different localities throughout the United States, and from various ecological situations The excretory system was taken as a conservative basis of description Luhes scheme of classification was used. Not only was preserved material studied, but the reactions of live cercarial were noted Cort, since then, has made several contributions to our knowledge of Digenetic larval trematodes

In 1917, Earl C O'Roke published a short paper on "Larval Trematodes from Kansas Fresh-Water Snails," [13] This study was less pretentious than that of Cort's but added several new species

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* Numbers in brackets refer to the literature cited

Also in 1917, Faust, in his preliminary report "Notes on the Cercariæ of the Bitter Root Valley, Montana," [8] listed 32 larval trematodes which had been previously described He described fifteen new forms Faust's completed monograph, "Life History Studies on Montana Trematodes"[9] takes up the biology of a limited region, a detailed embryological and morphological study of the trematodes found there and their systematic relationship Faust used not only the excretory system of live cercariæ as a basis of classification, but also worked out a method of staining the genital cell masses of the preserved material

In 1919, Faust presented in "The American Naturalist," (No 10, pages 85-92), a biological survey of cercariæ described from the United States up to that time The total number of host records was 72 The net species was 61, as there were eleven species of larval trematodes recorded from two or more hosts In 1921, the same author [11] described nine new larval distomes out of only two species of snails from the region of Rome, Georgia

Other papers have appeared describing new species, clearing up developmental problems or group relationships, and some of the various phases in the irregular and complicated set of life histories Despite the recent advances in parasitology, it is safe to say that only a limited area in the United States has been surveyed for larval trematodes Also, the life-history and ecology of most of those named are only incompletely known According to H B Ward [17, page 415], even the larva of the common sheep liver fluke, Fasciola hepatica, had not been reported from the United States up to 1918 Two years later, Mark F Boyd, of the University of Texas, experimented to determine the intermediate host He states [2] "Data presented do not enable us to conclude that the larval cycle can be completed in Physa, nor settle the question regarding Limnæa humilis "

APPLICATIONS OF THE PROBLEM

This last problem is of recognized economic importance in certain sections of the United States in connection with the live stock industry Beside the fact that Fasciola hepatica is an occasional human parasite there are further reasons for a study of "flukes" and their host relationships Cort[6] suggests the need of finding out what snails in this country may act as intermediate hosts for the more serious trematodes which have already been introduced into this country by Orientals

However, the immediate economic application of my study is to the problems of aquiculture—for example, to fish culture in Lake Erie and the streams of the state At the same time and place that this investigation of the snail parasites was in progress, the fish parasites of Lake Erie were being studied by R V Bangham During his work, my attention was called to his finding, in the digestive tract of the Small Mouth Bass, entire snails Not only did this show that snails, which serve as food for fish, were a possible source of infection, but Digenetic trematodes were found as parasites of the fish

F C Baker's ecological study [1, pages 153-154, 238-246], "The Realtion of Molluscs to Fish in Oneida Lake," shows the importance of a knowledge of snail parasites

DEFINITION OF TERMS

Out of the literature on trematodes certain terms have evolved At this place it may be well to define some of the terms used throughout this paper

According to Faust [9, pages 18 and 19], who follows Thomas (314), "the 'sporocyst' is the metamorphosed miracidium It is merely a sac with endoderm covering and at times a secretory integument Occasionally one end is partially muscular From the inner wall of this sac arise the germ balls that grow into the parthenogenetic individuals In the simplest types the germinal cell mass consists of the entire internal layers lying next to the ectoderm In the majority of cases, however, the germinal tissue is localized at one end of the sporocyst (C dendritica Fig 87, C racemosa Fig 105) In the furcocercariæ, C gracillima and C tuberistoma (Fig 147, 157), there is a rhizoid-like attachment at the germinal end In these cases there seems to be some evidence for regarding the germinal layer as localized at the end opposite the potential mouth "

Unless the rediac stage is omitted, it normally develops within the sporocyst stage Faust states [9, page 20] "Its organization is much more complex than that of the sporocyst There is a well developed oral aperture, a muscular pharynx and a sac-like gut There is a birth-pore just behind the collar region, on the left side, slightly ventral Two projections, usually in the posterior part of the body, readily differentiate the redia externally from the shapeless sporocyst In the cephalic region around the pharynx there is a nerve complex of highly differentiated nerve cells and nerve fibers The integument is well developed and thick, and muscular layers within it play an important role in the movement of the redia, whereas the sporocyst depends almost entirely for its movement on the larva within it In the mature redia the germ tissue is always localized at the posterior extremity of the body "

In another connection Faust states [10, page 92] "Sporocysts and rediæ have not been sufficiently distinguished The sporocyst is an adult which has lost its digestive tube, while a redia is an adult which possesses both a rhabdocœle gut and a pharyngeal sphincter In certain sporocysts the sphincter still remains, as in C dendritica In other sporocysts, as in furcocercariæ, while no definitely differentiated sphincter is present, the anterior end of the sac is muscular, turning in and out like the finger of a glove This may be mistaken for a rhabdocœle gut "

According to Faust [9, page 14], Ssinitzin groups the mature sporocysts and redia together under the term "parthenita," or parthenogenetic mother The term is used throughout this paper to define the mature sporocysts and redia as distinguished from cercaria or other larval trematode of the hermaphroditic generation "

PROCEDURE

In this study of comparative parasitization, the snail hosts will first be considered Representatives from all the available fresh-water snails were collected, in July from the Bass Island region, and in October and November from the Olentangy river The various snails were collected from a number of places in these regions, whenever their range of distribution was not limited to a definite ecological situation Representative shells from the lots examined were identified by Mr Bryant Walker, of Detroit These were the lake snails examined Limnæa humilis, Goniobasis livescens, Physa ancillaria, Planorbis parva, Planorbis trivolvis and Pleurocera acuta The river snails were Limnæa humilis, Ancylus rivularis, Goniobasis livescens, Physa ancillaria and Planorbis trivolvis

A few snails were collected at a time and examined as soon as possible thereafter The examination in each case consisted of first crushing the snail or removing the shell piece by piece from the body Then the snail was placed in a watch glass in a small amount of water Only enough water was used to allow movement of parasites when freed from the snail tissue Under a binocular microscope the body of the snail was teased apart with needles If no parasites were detected in a given snail, the watch-glass in which the examination was made, was washed out before examining another snail If trematode parasites were present in a given snail, they could be detected both by general appearance and by movements, often characteristic for different trematodes These peculiarities, as to reactions of live cercaria, as well as the relative number of parasites present were noted Each lot of parasites from a single snail, were fixed in Hofer's solution and preserved in alcohol for later study Every lot was kept in a bottle labeled with the serial number of the snail from which it came In this way the number of snails examined from each species, the number parasitized in each species and the approximate infection of any snail examined was recorded

The arbitrary terms used for this last item were "few" for less than ten parasites, "many" for from ten to about one hundred and "very many" for the heaviest infections

After examining 1043 snails representing the seven species previously named, attention was turned to a study of the trematode parasites obtained from them From the preserved material, "toto" mounts were made of both parthenitæ and larvæ (cercariæ) These were studied under the compound microscope Measurements were made of cercariæ and parthenita The parthenita stage, whether sporocyst or redia, accompanying the various cercariæ was noted. From the literature that is now available, identifications were made Ward's "Key to North American Trematoda" [17, pages 411–424] was supplemented by one of his shorter papers, the more complete descriptions in the monograph by Cort [5] and Faust [9], and the paper by O'Roke [13]

DATA IN TABLE FORM

In the tables that follow is presented a comparative study of the parasites found in this investigation. The exact number of snails examined, the ones parasitized and observations as to the parasites are recorded

SNAILS FROM REGION OF PUT IN BAY OHIO COLLECTED JULY 1921

Host	Location	Number Examined	Parasitized		Serial Number	Name of Parasite	Kind	Parthenita		Cercaria (larva)
			Number	Percent				Sporocyst	Redia	
Limnaea humilis	Squaw									
	Harbor	100	0	0						
Physa	Chicken I				304		Distome			✓
ancillaria	Buckeye I				336	(Lost)				Few
ancillaria	Hatchery				358		Distome			✓
ancillaria	Bay				364	C urbanensis	Monostome		✓	✓
ancillaria	Bay				379	C urbanensis	Monostome		✓	✓
ancillaria	Chicken I	100	6	6	397	C gracillima	Distome			✓
Planorbis	Chicken I				208	(Lost)				
parva	H Bay				255	C urbanensis	Monostome			Many
parva	H Bay				275	C urbanensis	Monostome		Few	Few
parva					273		Distome			
parva	Sq Harbor				297	C urbanensis	Monostome		Few	
	Sq Harbor	100	5	5	298	C urbanensis	Monostome		Few	
Planorbis trivolvis	Sq Harbor	46	1	2 17	640	C echinocauda	Distome	✓		✓
Pleurocera	Sq Harbor				4					✓
acuta	Sq Harbor	100	2	2	7			✓		✓

SNAILS FROM REGION OF PUT IN-BAY, OHIO, COLLECTED JULY, 1921—Continued

Host	Location	Number Examined	Parasitized		Serial Number	Name of Parasite	Kind	Parthemta		Cercaria (larva)
			Number	Percent				Sporocyst	Redia	
Goniobasis	Hatchery				501	C microcotylae				
livescens	Bay				502	"	Distome			Many
"	"				509	" "	"			✓
"	Hen Island				512	C anchoroides	"			✓
	Hatchery				514	C microcotylae	"			✓
"	Bay				532	" "	"			✓
"					545	" "				Many
"					549	C urbanensis Cort. 1914	Monostome			✓
	"					C microcotylae	Distome			✓
"					556	" "	"	Few		Few
"					557	"	"	Few		Few
"	"				559	"	"			✓
"					560	"	"			✓
"					565	"	"			Few
"					567	"		Very many		✓
"	"				568	" "	"			✓
"	"				574	"	"	Very many		✓
"	"				576	"	"			Very many
"	"				581	"		Many		✓
"	"				595		"			Few
"	"	100	19	19	599		"	Few		Few

SNAILS FROM OLENTANGY RIVER COLUMBUS OHIO COLLECTED OCT NOV 1921

Host	Location	Number Examined	Parasitized		Serial Number	Name of Parasite	Kind	Parthenita		Cercaria (larva)
			Number	Percent				Sporocyst	Redia	
					1432	(Lost)				Few
Limnaea humilis	Olentangy Riv	100	2	2	143[illegible]	(Lost)				Few
Ancylus rivularis	"	100	0	0						
Goniobasis livescens					904	C pachycerca				
"					905	"	Distome	Few		
"						C microcotylae	"			Many
" "					910	"	"			
"					938	C megalura	"			
" "					96[illegible]	C gracillima			Many	
" "					963			"		
"		86	7	81	965	C megalura		Many		Very many
Physa ancillaria	Olentangy Riv				703	C urbanensis	"		Many	Many
"					801		Monostome		Few	Many
"					804				Few	Few
" "	"				812	(Lost)			"	"
" "	"				815	Lost in clearing				Few
"					816	(Lost)?	Distome		Few	Few
"					822					1
" "					838		Distome		Few	Very many
" "					1302	(Lost)?			Many?	
"	"	200	10	5	13[illegible]2	(Lost)?				"
Planorbis trivolvis	Olentangy Riv	9	0	0						Many

COMPARATIVE PARASITIZATION SUMMARY

Species of Snail Host	Location of Snail Hosts	Number Examined	Parasitized		Species		Stages	
			Number	Percent	Monostome	Distome	Parthenita	Cercaria
Limnaea humilis	Lake Erie	100	0	0				
Limnaea humilis	Olentangy River	100	2	2		✓		✓
			(2)	(1)				
Ancylus rivularis	Olentangy River	100	0	0				
		100	20	20	1	✓	✓	✓
Goniobasis livescens	Lake Erie	86	7	8.1		✓	✓	✓
Goniobasis livescens	Olentangy River		(27)	(14.5)				
		100	6	6	1	✓	✓	✓
Physa ancillaria	Lake Erie	200	10	5	1	✓	✓	✓
Physa ancillaria	Olentangy River		(16)	(5⅓)				
		100	5	5		1	✓	✓
Planorbis parva	Lake Erie	46	1	2		1		
Planorbis trivolvis	Lake Erie	9	0	0				
Planorbis trivolvis	Olentangy River	100	2	2		✓	✓	✓
Pleurocera acuta	Lake Erie	1043	53	5.08				

DISCUSSION

The data here presented in table form indicates that seven species of fresh-water snails have been examined for parasites Of these, six species are shown to be parasitized by Digenetic larval trematodes The incidence of larval trematode infection of fresh water snails is shown From 1043 specimens examined, 53 snails, or more than one in every twenty were parasitized by some stage of Digenetic trematode Of the 53 host snails, thirty are represented by mounted material, ("toto mounts') Instead of redescribing the identified parasites the source of the original description is given Some variations or additional facts are noted

Cercaria urbanensis Cort 1914, was the only species of monostome found Either the parthenita or larva stages of this parasite were found in seven snails The hosts in which this specie was found were Physa ancillaria in one snail each from the river and lake, Planorbis parva in four out of 100 Lake Erie snails, and a lake specimen of Goniobasis livescens The morphological characteristics fit the description for Cercaria urbanensis given by Cort [5 pages 11 17) and in Ward's Key [17, page 412] Part of Cort's record of infection is quoted [5, page 11) "About five percent of the largest specimens of Physa gyrina from a drainage ditch North of Urbana Illinois, examined in December, 1913, were infected with the redia and cercaria of a monostome The infection was in the liver of the snail and there were present both rediæ in different stages of development and free cercariæ "

Of the distome cercaria there were several kinds Nineteen percent of the lake specimens of Goniobasis livescens were heavily infected by small distome cercariæ Both the larva and parthenita stages respectively were very similar in all of these small distomes They are very closely related to Cercaria leptocantha, a Xiphidiocercaria described by Cort [5, pages 59-62, figures 79-81] He says of this species (5, page 60 61) "Cercaria leptocantha belongs to a group of very small cercariæ which Luhe [12, 1909, page 106] calls Cercaria Microcotylæ It is possible that they form a natural group * * * They are, however, so insufficiently known that no final judgment can be passed on their relationships At present it seems best to follow Luhe in considering them a provisional group, with Cercaria microcotyla Fillippi as the type and the following characteristics

1 Developed in gastropods in round or oval sporocysts which are seldom more than twice as long as wide

2 Cercaria under 0 2 mm in length

3 Acetabulum back of the middle of the body and smaller than the oral sucker

4 Stylet glands not more than four on each side and arranged in rows on each side of the acetabulum

5 Digestive system undeveloped except for a short prepharynx and a small pharynx "

A much larger distome, a gymnocephalous cercaria closely related to the cercaria of Fasciola hepatica is identified as Cercaria (Gymnocephala) ascoides Leidy 1877 It was found in a specimen of Planorbis parva from Lake Erie Cercaria urbanensis was found in the same snail This is a case of double infection, one parasite being a monostome and the other a distome There were only two of these relatively large distomes It may be noted in this connection that there seems to be little relation between the size of the snail host and the trematode parasite The smallest cercaria, as well as the largest, was found in Goniobasis livescens Goniobasis livescens is one of the largest of the seven snails examined, being many times the size of Planorbis parva, which is the smallest of these snail hosts

The other species of distome, from a lake specimen of Goniobasis livescens, was Cercaria anchoroides This peculiar cystocercous cercaria was described by Ward [15] from free-living specimens which he found in Lake St Clair between July 27 and August 5, 1893 In 1916, he again described this cercaria, [16], but reported no host for it On July 17, 1921, from snails taken in Lake Erie off the shore of Hen Island, I found not only a cercaria in the characteristic anchor-like stem, or tail which pulls the cercaria along, but also sporocysts In one of these brown colored sacs, the inverted flukes and anchor stem were protruding at right angles to the sporocyst wall In another case, the forked tail or wings of the anchor could be seen inside the sporocyst The reversal of functional activity in the tail of the live cercaria, the wavy outline of the intestine and the proportion of parts indicate that the larval trematode found near Hen Island is of the same species as that described by Ward from

Lake St Clair The host of this peculiarly specialized cercaria is for the first time recorded as Goniobasis livescens

At least three species of the distomes were furocercariæ, if the large cystocercous larva, Cercaria anchoroides, is included One of these forked-tailed cercariæ was concluded to be Cercaria echinocauda described in 1817 by O'Roke, [13, pages 170-171, figures 39-43) He states, [3, page 170) "Six percent of large numbers of Physa gyrina collected at Lakeview, Kan August 20 were infected with a form for which I propose the name Cercaria echinocauda Collections of snails from the same locality made October 12, showed two percent to be infected " In this investigation, the host was Planorbis trivolvis from Lake Erie Only one snail was infected by this parasite O'Roke's description of Cercaria echinocauda fits for this parasite, with the exception of his Figure 39 on Plate V That figure shows the large pigmented eyespots to be set with their long axis at about a forty-five degree angle to the long axis of the body, with the anterior ends of the eyespots farther apart than the smaller posterior ends A camera lucida drawing with the 4 mm objective of the parasite from Planorbis trivolvis, which agrees in other respects to the one O'Roke described, shows definitely that the eyespots are set at right angles to the direction which his drawing represents The anterior ends of these eyespots are directed toward a point which would be midway between the region of the eyespots and the extreme anterior end of the body

Several specimens of a forked-tailed cercaria, found in a specimen of Physa ancillaria from the Olentangy river, were lost in clearing

The other species of furcocercariæ was found twice in Goniobasis livescens from the Olentangy river and once in Physa ancillaria from Hatchery Bay, Lake Erie Faust's description for Cercaria gracillima (9, pages 80-82, figures 142-154), from Montana more nearly fits the parasites from these three specimens than any other description that I have seen According to Faust [10, page 91] "None of the species described for the Bitter Root Valley have been recorded east of the Rocky Mountains " This may only indicate the small geographical area that has been covered, for, as he suggests on the same page the same condition is not true in general for other larval trematode parasites The following is the record of parasitization as given by Faust [9, page 81] "This species was found in the liver of Physa gyrina Say, collected from the lower reaches of the Bitter Root River near Maclay Bridge, Buckhouse Bridge, and the sloughs at the roadhouse, near Fort Missoula, in the fall of 1916 In addition, it was found in the livers of Limnaea proxima Lea from Rattlesnake Creek, Missoula The infection in most cases was not exceedingly heavy, except in the collection from the sloughs at the Roadhouse, where thirty-three out of seventy-one individuals were infected, or 46 5 percent

Out of the 87 specimens of Goniobasis livescens from the Olentangy River, seven were infected Of these, two infestations were with microcotylous cercariæ similar to those from the lake specimens of Goniobasis

In two of the 87 snails there were larvæ identified as Cercaria grocillima Faust 1917

Two other individuals of Goniobasis livescens from the river were infected with Cercaria megalura Cort 1914 [5, pages 31–36, figures 27–36] Beside the group of gland cells forming an adhesive organ in the tip of the contractile tail, the shape, size and other characteristics make this identification very certain

Also, different specimens of the mounted parasites showed, as Cort's figures do, a varying amount of the cytogenous material within the body or thrown out around it As to the classification, Cort removed this trematode from the subdivision of Gymnocephalous cercaria He calls it a megalurous cercaria, from the characteristic appearance of the tail As to the parasitization of his material Cort states [5, page 31] "From 73 specimens of Pleurocera elevatum from Sangamon River near Mahomet, Illinois, examined during November and December, 1913, one was found with the liver packed with redia in which developed a very peculiar kind of cercaria Comparison showed this form to be the same as the larger cercaria which Cary assigns to Diplodiscus temporatus " Cary's snail host was Goniobasis virginica Say from Princeton, New Jersey (1908) He left no record as to the extent of parasitization

In two specimens of Goniobasis livescens from the Olentangy River were cercariæ which to my knowledge have not been described from North America They differ from Cercaria trigonura Cort 1914, [5, pages 49–52, figures 47–54], in their stumpy tails which are truncate, nearly as broad as long and the width about the same at each end The tail of a representative cercaria measured 0 066 mm long by 0 055 mm wide The cup-like end functions as a sucker rather than the ventral part of the triangular shaped tail of Cercaria trigonura The bladder is large and entire as contrasted with the bicornuate excretory vesicle of Cercaria trigonura It extends above the acetabulum occupying almost the posterior two-fifths of the body Aside from the tail and size, the general appearance of the body of this cercaria is similar to that of Cercaria trigonura

These distome cercariæ from Goniobasis livescens average about 0 4 mm in length by 0 1 mm in width Cercaria trigonura Cort 1914 [5, page 45] is stated to measure 0 24 mm in length and 0 06 mm in width Further, their parthenitæ differ both in size and kind Cercaria trigonura develop in rediæ measuring 0 43 mm in length and 0 09 mm in diameter [5, page 47] The stumpy-tailed cercaria from Goniobasis livescens develops in sporocysts like the Cotylocercous cercariæ of Dollfus [7] While the size of the parthenita, as well as the cercariæ varied slightly, the relative size of the two is shown by these measurements taken respectively from an average sized cercaria and a sporocyst mounted together cercaria 0 4 mm by 0 1 mm and sporocyst 2 mm in length by 0 5 mm in width

Robert Dollfus in his preliminary report at the Ninth International Congress of Zoology held at Monaco in 1913 [7, page 684], says * "The group of Cotylocercous cercaria, with the common type Cercaria pochycerca Diesing, are characterized as follows a large bladder, not bifurcate, occupying nearly all of the posterior part of the body Beginning with the ventral sucker its wall is formed of a single layer of very large closely fitted granular cells of glandular appearance Tail very short, large at least at its base, consisting of a cup with very thick wall and large cells The bottom of the cup and the sides by their combined movement permit of adhesion to a support after the manner of a sucker This tail, functioning as a sucker, is well developed "

These stumpy-tailed cercariæ from Gonibasis livescens are identified as belonging in the group of larval trematodes which Dollfus calls Cotylocerous, with Cercaria pachycerca Diesing as the type species

Some observations as to the ecology of this and other larval trematodes may be in place Reference has already been

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*Translated from the French by James E Davis, O S U made to the apparent lack of relation of the size of the snail host to that of the parasite It will be observed from the tables that Microcotylous cercariæ were the predominant parasites of the lake specimens of Goniobasis In the individuals of Goniobasis from the Olentangy River, there were no Monostome cercariæ, but there was a wider range in the type of distome larvæ There was a double infestation at each place

From the river, two individuals were infested with Cercariæ microcotylæ (very small distomes), two with Cercaria pachycera (a stumpy-tailed larva) two with Cercaria gracillima (a forked-tailed cercaria with eye-spots) and two with Cercaria megalura with the characteristic group of cells for attachment in the end of the long tail Other particulars might be stated as to the parasites and the environment of the snail hosts However, the general conclusions of Dollfus as to the ecology of larval trematodes is borne out by this study of their comparative parasitization

As to the relation of the morphology of the trematode parasites to the environment Dollfus states [7, page 685] "After comparative examination of the morphology of the cercaria and the condition in which the host lives I have been able to submit that cercariæ with a morphology very similar have hosts very different and lives very different Cercaria very different inhabit the same environment ("Milieu") I have been able to establish that it is only arbitrarily that one attributes certain forms to certain places "

Faust [10] states in this connection that, "The mollusks most heavily infected are the ubiquitous species, Planorbis trivolvis and Physa gyrina, and the western species Lymnea proxima

Beside calling attention to the limited geographical areas that have been covered in the survey for cercaria Faust suggests that [10, page 91] "the variation of species of flukes in snails from one season to another makes it highly probable that many more species occur in the mollusca of the areas surveyed than the records show "

SUMMARY

The comparative parasitization of seven species of freshwater snails, totaling 1,043 specimens, has been studied The species were Limnæa humilis, Ancylus rivularis, Goniobasis livescens, Physa ancillaria, Planorbis parva, Planorbis trivolvis and Pleurocara acuta

Six of these species have been shown to be parasitized by the larval stage of Digenetic trematodes No parasites were found in the 100 specimens of Ancylus rivularis

The kinds of cercaria identified were monostomes (Cercaria urbanensis Cort 1914),

Distomes

Microcotylous, having as type species (Cercaria leptocantha Cort 1914)

Furcocercous, (Cercaria echinocauda O'Roke 1917),
(Cercaria gracillima Faust 1917)

Cystocercous, (Cercaria anchoroides Ward 1916)

Megalurous, (Cercaria megalura Cort 1914)

Stumpy tailed or Cotylocercous, (Cercaria pachycerca Diesing)

The approximate degree of parasitization of individual snails has ranged from none, (in Ancylus rivularis), to several hundred, (in the case of Goniobasis livescens parasitized by Cercariæ microcotylæ)

There were two cases in which two species of trematodes were found in a single host In one of these cases, one parasite was a monostome and the other a distome larva

Little, if any, relation was found between the size of the host and the size, or number of its parasites

The percentage of parasitization found for the seven species of freshwater snails was as follows

Goniobasis livescens	14 5 percent
Physa ancillaria	5 33 "
Planorbis parva	5 0 "
Pleurocera acuta	2 0
Planorbis trivalvis	2 0 "
Limnaea humilis	1 0 "
Ancylus rivularis	0 0 "

The incidence of larval trematode infection among certain fresh-water snails has been shown to be over five per cent

A host, Goniobasis livescens from Hen Island, Lake Erie, was found (July 17, 1921) for Cercaria anchoroides previously only recorded as free-swimming

A stumpy tailed distome Cercaria pachycerca Diesing, has been reported as a new species from North America

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CHEMICAL COMPOSITION OF THE WALLS OF CERTAIN ALGAE *

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INTRODUCTION

In spite of the fact that numerous investigations of the nature of cell walls of algæ have been made, the recorded data are still far too incomplete to be of the greatest service to science It is usually impossible to obtain from the literature a complete record of the composition of the walls of the most commonly occurring fresh water algæ The physiological nature of the cell walls of algæ appears to play an important role in such phenomena as the resistance of certain algæ to desiccation during dry seasons the rate of entrance of certain mineral elements, the attachment or nonattachment of epiphytic algæ, and the utilization of algæ as food by fishes and other aquatic animals It seems important that a thorough knowledge of the composition of the cell walls of algæ should be obtained The object of the investigation reported below was to determine the composition of the cell walls of some of our common algæ Representatives of the following genera were studied *Vaucheria*, *Cladophora*, *Oedogonium*, *Spirogyra*, *Zygnema*, and *Draparnaldia*

LITLRATURE

Only those papers dealing with investigation of the genera listed above will be reviewed in this paper In 1913 Mirande (4) reported that the cell walls of *Vaucheria* were composed entirely of cellulose-pectic compounds He did not state whether these compounds were intermingled or in separate layers, or in what form the pectic compounds occurred

Brand (1) states that stratification of the cell walls of *Cladophora glomerata* begins in a very early stage, young filaments of two cells being composed of two layers The outermost layer surrounds the entire filament and is loosened from it by dilute acetic acid or other weak acids Potassium hydroxide, alcohol, and acid free glycerine have no effect on it This membrane appears to be independent of either of the other two membranes constituting the second layer of the cell wall It gave no positive reactions for cellulose The cellulose reaction was obtained with difficulty, so that it seemed that the pectic compounds predominated in the membrane Chlorzinc iodide gave no blue color even after boiling with hydrochloric acid

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*Papers from the Department of Botany Ohio State University No 141

Hirn (3) found the cell walls of Oedogonium to be composed of two layers The inner one was a moderately thick layer of cellulose and the other a "cuticle" which enclosed the entire filament This "cuticle" could not be identified with that of the higher plants by means of either stains or other reagents

Hirn also reports (3) that the beginning of the new partition wall in Oedogonium was at first a thin cellulose ring This ring enlarges and appears stratified, and separates into two entirely different regions The outer one of these regions gives a positive cellulose reaction and the inner one a negative reaction for cellulose Klebahn says [according to West (7) and Oltmanns (6)] that the ring is of a gelatinous nature and stains with hæmatoxylin The young membrane which comes from the ring stains in the same manner while the older membranes do not

Czapek (2), in his discussion of the cell walls of the green algæ, states that Klebs found the wall inside the gelatinous sheath of *Zygnema sp* to have no homogeneous composition Part of the membrane, which in the normal cell membrane stained with the aniline dyes, was dissolved by heating in dilute hydrochloric acid The remainder of the cell wall was readily dissolved in copperoxide ammonia, stained with congo red and gave the usual cellulose reactions

West (7) reports all the members of the group Conjugatæ to have a firm cellulose wall and some to have a great development of the mucilaginous pectose constituents of the cell wall This development may be through the conversion of the outer cellulose layers into mucilage or by mucilage being continually exuded through the cell wall

METHODS OF INVESTIGATION

All the filaments were mounted in distilled water and examined in polarized light The results of these data were then checked by color reactions, hydrolysis, and solubility of the membranes

The following tests were used in the identification of the substances found

1 Cellulose Cellulose is doubly refractive in polarized light, stains blue with iodine potassium iodide and 70% sulphuric acid, and is soluble in copperoxide ammonia The filaments are left intact when the cellulose has been removed and will then give a negative hydrocellulose reaction and show no double refraction in polarized light

2 Pectic Compounds All pectic compounds are singly refractive in polarized light The different compounds are distinguished by their different solubilities Pectic acid is soluble in 2% potassium hydroxide or in 5% sodium carbonate, and is dissolved from the filament by treating it with either of these reagents If the filament still shows the presence of a pectic compound it is then treated for the removal of calcium pectate.

Calcium pectate is broken down by 2% oxalic acid, giving calcium oxalate crystals and pectic acid The calcium oxalate crystals may be recognized by their tetragonal shape and their double refraction of polarized light The pectic acid may be removed by dissolving it in 2% potassium hydroxide or 5% sodium carbonate as stated above

Any pectic compound remaining is pectose and is dissolved by heating the filament on the water bath 20—30 minutes in 2% hydrochloric acid and then treating with 2% potassium hydroxide The hydrochloric acid breaks the pectose down to pectin or pectic acid If to pectin, the compound is removed by washing the filament in water If to pectic acid the potassium hydroxide dissolves it

If fresh untreated tissue is used in making these tests, the cells are left intact after all the pectic compounds have been removed These cell walls will then react negatively for pectic compounds in polarized light, but positive by for any other substance composing the walls

3 Chitin Chitin, when present, seems to be in a thin layer on the outside It is singly refractive and can not be distin-

guished from the pectic compounds in polarized light Tissues containing chitin give a positive chitosan reaction Filaments of the alga are placed in boiling concentrated (50%) potassium hydroxide, and allowed to boil in a covered dish for 30 minutes The filaments are then hardened in 90% alcohol, mounted in iodine potassium iodide, and dilute sulphuric acid added A red violet color, characteristic of chitosan, is obtained

REPORT OF INVESTIGATION

VAUCHERIA GEMINATA In polarized light the cell walls of *Vaucheria geminata* are composed of two layers, the outer one being singly refractive and the inner one doubly refractive This outer layer gives positive reaction to all tests for pectose Other pectic compounds, if present, occur only in small amounts Before treating with the pectose solvents the inner layer reacts negatively to the hydrocellulose reaction, although it is dissolved in copper oxide ammonia if left in the solution two days, the solution being changed three times After the removal of the cellulose the filament, now composed only of pectose walls, is left intact although very fragile After removing the outer layer of pectic compounds, the inner layer of the cell wall reacts readily to the cellulose reagents, giving a positive test to the hydrocellulose reaction and dissolving rapidly on the slide in copperoxide ammonia The entire cell wall is dissolved when treated with the solvents for both pectic compounds and cellulose

The mature oospore seems to have a layer in addition to the two present in the cells of the filament A thin membrane is left intact after both the pectic compounds and the cellulose have been removed This membrane is broken by the pressure of the cell contents while the swelling cellulose is being dissolved The cell contents move out of the oospore wall leaving it intact as an empty shell This shell is singly refractive It may be chitin but the exact composition has not been determined

To summarize the work on *Vaucheria geminata* the cell walls are composed of pectose and cellulose, the former being on the outside This outer pectic layer is very difficultly permeable to cellulose reagents, particularly those used in the hydrocellulose reaction, presumably iodine, though this point was not definitely determined The mature oospore has an additional outer layer which may be chitin

CLADOPHORA GLOMERATA The cell walls of *Cladophora glomerata* are composed of three layers The outermost layer is of chitin and can be separated from the rest of the filament by dilute acetic acid This layer is singly refractive in polarized light, insoluble in either pectic or cellulose solvents, and gives a positive chitosan reaction

The second layer is also singly refractive in polarized light but is soluble in the pectose solvents The inner layer is doubly refractive in polarized light but gives the characteristic cellulose reactions only after the filament has been treated with pectose solvents Then the cellulose is readily dissolved leaving only the outermost layer of chitin

Therefore, the cell walls of *Cladophora glomerata* are composed of three layers chitin, pectose, and cellulose The layer of chitin is readily separated from the rest of the cell wall and is the only membrane left intact after the filaments have been treated with pectose and cellulose solvents This layer is also evidently very difficultly permeable to cellulose reagents until partially hydrolyzed It appears to be more impermeable to copper than pectose is It is interesting to note in this connection that Moore and Kellerman (5) find that the per cent of copper sulphate required to destroy Cladophora in reservoirs is twenty-five times that required to kill Spirogyra which has no chitinous membrane

OEDOGONIUM IRREGULARE The young filaments, of from one to two cells in length, of *Oedogonium irregulare* give no reaction for the presence of cellulose They are composed of two layers, the outer one of which may be separated from the other and be made to bulge out by dilute acetic acid This layer gives the chitosan reaction and is singly refractive in polarized light It surrounds the entire filament but does not form a part of the cross cell walls The inner layer of the wall is of pectose and may be dissolved by heating in 2% hydrochloric acid for one-half hour and then leaving in 2% potassium hydroxide for 15 minutes or longer The outer layer is left intact after this treatment

When the filament is older and is composed of two or more cells, a third layer appears inside the layer of pectose This layer is doubly refractive, but gives the cellulose reactions only after the filament has been treated for the removal of pectose The layer of chitin is evidently partially hydrolyzed by this treatment since a slight chitosan reaction is also obtained when applying the hydrocellulose test This layer of chitin and the layer of pectose are undoubtedly the membranes which prevent the entrance of copper and iodine into the cell when tests are made for cellulose and may explain why it has been generally considered that the cell walls of water plants were composed of difficultly soluble cellulose In these investigations it was found that when these impermeable layers were removed or hydrolyzed the cellulose in the walls of algæ is no more difficultly soluble than that in higher plants

OEDOGONIUM CRASSUM AMPLUM The walls of the vegetative cells of *Oedogonium crassum amplum* are stratified and composed of three substances The outer layer surrounds the filament as a whole and can be readily separated from it by treatment with copperoxide ammonia When this solution is run under the coverglass the outer membrane swells and bulges out from the other membranes, but does not dissolve It is not caused to separate from the filament when treated with acetic acid as was the case in *Oedogonium irregulare* It is singly refractive and, although it is soluble in neither pectose nor cellulose solvents alone, it is finally dissolved with the rest of the cell wall when both solvents are used It apparently is not a mixture of cellulose and pectic compounds since it does not give a positive reaction for celluolse when the pectic compounds are removed It gives a negative reaction for pentosans

The second layer of the cell wall is of pectose and is dissolved in hydrochloric acid and potassium hydroxide This membrane is singly refractive in polarized light

The inner layer is doubly refractive and gives the characteristic hydrocellulose reaction for the presence of cellulose When the sulphuric acid is added in the hydrocellulose reaction, the cellulose membrane seems to loosen at one end of the cell and expand, remaining attached at the other end In the same reaction the filament undergoes a series of color changes before the final blue color is attained The filament becomes red and then goes through violet to the characteristic deep blue color of cellulose After being treated with the pectose solvents, the filament is stained red directly with iodine potassium iodide, then changes to blue when 60% sulphuric acid is added These peculiar color changes indicate the presence of some unidentified substance in the walls of this alga

When the sulphuric acid or copperoxide ammonia is added the cells separate from each other, the cellulose layer swells rapidly becoming many times its original thickness, then it divides into two or more parts forming distinct cylinders which rapidly slip out of each other before going into solution The entire filament is soluble in copperoxide ammonia after the pectic compounds have been removed The pectose solvents evidently partially hydrolyse the outermost layer which may be composed partly of some form of chitin or a hemicellulose

The ring, which is the first indication of the new partition wall in cell division, is singly refractive in polarized light, indicating that it is not pure cellulose It is insoluble in either the pectic solvents or the cellulose solvent when they are used alone, but when the filament is treated with both groups of solvents the ring is dissolved as well as the rest of the cell wall It gives a faint blue when treated with the hydrocellulose reagents, but gives a negative test for cellulose under polarized light both before and after treatment with pectose solvents

To sum up, the cell walls of *Oedogonium crassum amplum* are striated and are composed of three substances an unidentified substance on the outside, which can be separated from the rest of the filament, a middle layer of pectose, and an inner layer of cellulose The ring formed in the dividing of the cells may be in part a mixture of pectose and cellulose, though it resembles rather closely the unidentified outer layer of the filament

SPIROGYRA FLUVIATILIS The cell walls of this Spirogyra are composed of two layers The outer layer is of pectose, being singly refractive in polarized light and dissolved from the wall by 2% hydrochloric acid followed by 2% potassium hydroxide The inner layer is of cellulose, but unlike that of Vaucheria, Cladophora, or Oedogonium, it reacts readily to both the hydrocellulose and solubility reactions for cellulose before any previous hydrolysis of the outer membranes of the cell walls This indicates that the pectic compound present in *Spirogyra fluviatilis* is not as impermeable to copper and iodine as in the other cases, and may explain why Spirogyra is so readily killed by copper sulphate as found by Moore and Kellerman (5)

In the formation of the conjugation tubes there is a gradual change in the composition of the walls as they increase in age During the slight bulging of the vegetative cell wall, which is the first indication of the formation of the conjugation tube, there is no obvious alteration in the original cell wall When the tube is completely formed, the cellulose extends only a short distance into the tube, the rest of the wall being composed of a single layer of pectose In a more mature conjugation tube of another species it was noted that the cellulose lined the entire tube, making the cell wall of two layers, the outer one of pectose and the inner one of cellulose as in the wall of a vegetative cell

To summarize, the cell walls of *Spirogyra fluviatilis* are composed of two layers, the outer one is of pectose and is readily permeable to reagents containing either copper or iodine, the inner layer is of cellulose and gives all the characteristic cellulose reactions In the conjugation tubes the cell wall is at first composed of a single layer of pectose, a layer of cellulose being formed later Four other species of Spirogyra examined showed the same cell wall structure as described above

ZYGNEMA CRUCIATUM The cell walls of *Zygnema cruciatum* are composed of three layers Around the entire filament is a thick mucilaginous sheath of pectic acid This sheath is singly refractive in polarized light and is dissolved in 2% potassium hydroxide Just inside the mucilaginous sheath is a more compact layer of pectose which may be removed from the filament by treatment with the pectose solvents The innermost layer of the cell wall is left intact after the outer layers have been dissolved This layer gives the characteristic cellulose reactions, being doubly refractive to polarized light, positive for hydrocellulose, and soluble in copperoxide ammonia These reactions are positive both before and after the pectic compounds have been removed, indicating that the pectic compounds in this species are also readily permeable to copper and iodine

DRAPARNALDIA PLUMOSA The filaments of *Draparnaldia plumosa* are surrounded by a thick slimy sheath This slime is singly refractive in polarized light and is partially soluble in 2% potassium hydroxide, more soluble in 5% sodium carbonate, and entirely soluble in the pectose solvents, indicating that it is composed of both pectic acid and pectose

The cell walls of the main filaments are composed of two layers The outer layer is of pectose and the inner one of cellulose Before the slimy sheath has been removed, the cellulose membrane gives a negative reaction to the hydrocellulose test After the treatment with pectose solvents, the cell walls of the main filament give a positive reaction to the hydrocellulose reagents The cell walls of the branch filaments are singly refractive in polarized light and give no hydrocellulose reaction, but when the filaments have been left in the potassium hydroxide of pectose solvent for several hours, they are dissolved, with the cell walls of the main filament, in copperoxide ammonia

The above data seem to indicate that the main filaments of *Draparnaldia plumosa* are composed of cellulose and pectose in layers, while the branch filaments are of a combination of cellulose and a pectic compound Of these two substances the pectic compound seems to predominate, masking the polarized light reaction of the cellulose present The entire filament is surrounded by a slimy sheath of pectic acid and pectose This sheath prevents the cellulose reagents from coming in contact with the cellulose, thereby preventing a positive test for cellulose until the slime has been dissolved

TETRASPORA The mucilaginous sheath surrounding the colonies of Tetraspora is singly refractive in polarized light and is soluble in dilute alkalies and alkalie carbonates, indicating pectic acid

SUMMARY

1 *The composition of the cell walls of algæ reported may be summarized as follows*

SPECIES	OUTER LAYER	MIDDLE LAYER	INNER LAYER	REMARKS
Vaucheria geminata	Pectose		Cellulose	Pectic layer difficultly permeable to copper and iodine reagents
Cladophora glomerata	Chitin	Pectose	Cellulose	Chitin very difficultly permeable to copper and iodine reagents
Oedogonium irregulare young filaments of 1 2 cells	Chitin		Pectose	Chitin very difficultly permeable to copper and iodine reagents
Oedogonium irregulare (older cells)	Chitin	Pectose	Cellulose	Chitin very difficultly permeable to copper and iodine reagents
Oedogonium crassum amplum	Unidentified	Pectose	Cellulose	Unidentified substance difficultly permeable to copper and iodine reagents
Spirogyra sp	Pectose		Cellulose	
Zygnema cruciatum	Pectic acid (sheath) mucilaginous	Pectose	Cellulose	
Draparnaldia (main filament)	Pectic acid and pectose mucilaginous sheath	Pectose	Cellulose	

2 In all the forms studied the cell walls are composed of at least two layers, an inner one of cellulose and an outer one of pectose or of chitin When chitin is present, pectose forms a middle layer of the cell wall

3 In some forms, as in Vaucheria and Draparnaldia, the pectose is difficultly permeable to a solution of copper-oxide ammonia and iodine-potassium-iodide

4 In other forms, *Cladophora glomerate* and *Oedogonsum irregulare*, a third layer composed of chitin is present, in *Oedogonium crassum amplum* a layer of an unidentified substance These outermost layers surround the filament and may

be separated from it by appropriate reagents These membranes are difficultly permeable to copper and iodine reagents until partially hydrolyzed

5 The cellulose present in the algæ is readily soluble in copperoxide ammonia when the reagent is free to come in contact with the cellulose

6 Mucilaginous sheaths of algæ studied are of pectic compounds, of which pectic acid predominates, with pectose in some cases

The writer wishes to express her indebtedness to Dr H C Sampson for directing the investigation, also to Mr L H Tiffany for the identification of species of algæ studied

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ALASKAN SPECIES OF DIPTERA OF THE GENUS HELOPHILUS, WITH NOTES ON OTHERS

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It appears that several of the species of Helophilus now known from America are considered in literature under two or more names, due mainly to the introduction of a number of European species which have been named after reaching this country, or to giving separate names to European and American specimens of species which are circumpolar as many insects are, especially in high latitudes

Most attention has been given in this consideration to the species which have a shining stripe on the face and all such species, known to me from the Nearctic fauna, are included in the key given below, while only a few of the dozen or more of the other section of the genus are treated Notes are given on a number of species not considered in the key in order to record some observations that may be of use to future students of the group

Much of my material was collected in Alaska by the Katmai Expeditions of the National Geographic Society Seven species belonging to the genus were procured in series, and pains were taken to associate the sexes, and to note such variations as were presented by each species in a study of large numbers in the field

Additional material was furnished by Chas W Johnson and special interest attaches to this since it was collected in eastern localities and furnished the opportunity for a comparative study of specimens from New Foundland, Labrador and Northern Maine with my specimens from Alaska Material in various museums was studied and the results used in the conclusions which follow The Dr Loew collection and the cabinet of Dr R C Osburn have proven interesting, as they present for study specimens from Greenland and Labrador from whence Otto Fabricius, Staeger and Loew procured their type material Chas L Fluke has aided me in getting information in regard to the type of Helophilus bruesi Graenicher He agrees that it is a synonym of borealis

The abdominal coloration of species of Helophilus with a shining facial stripe is much the same in all Thus groenlandicus, which was one of the first American species described, may be considered typical The ground color is clear black, with an interrupted band of different color on each of segments two, three and four Segment two has a rather large triangular yellow marking on either side with the inner angles distinctly gray Segment three has a small yellow spot, somewhat variable in size, at each anterior corner and proceeding inward from it a conspicuous narrow gray marking, which does not meet its fellow of the opposite side Segment four has the gray markings similar, but does not have any yellow whatever Wherever the color is yellow the black is replaced, but the gray usually is over black and can be rubbed off quite easily, leaving black in its place In at least two forms described, dychei Williston and bruesi Graenicher, the gray abdominal markings are omitted in nature, but the yellow and black persist in typical arrangement

1 Face, between oral margin and base of antennæ, with a shining stripe devoid of pile or pollen 2
Face without such a stripe, entirely pollinose 8
2 Facial stripe yellow or at most brown 3
Facial stripe deep shining black 4
3 First two segments of antenna black, front of female black pilose only near the ocelli, front of male broad *trivittatus* Fabr
First two segments of antenna reddish, front of female black pilose, front of male narrow *similis* Macquart
4 All segments of all the tarsi black 5
At least one basal segment of each middle tarsus yellow for its entire length 6
5 Thoracic stripes more or less irregular, usually not distinct, two median ones usually reaching only to the posterior fourth of the mesonotum Thorax long yellow pilose, very rarely some black pile on the scutellum Abdomen with the black almost wholly shining, fourth segment entirely black or with a narrow, more or less obsolete, interrupted, gray pollinose band *borealis* Staeger
Thoracic stripes regular, distinct, two median ones reaching very near to the scutellum Thorax with rather short pile which regularly is black on the disc of the scutellum, abdomen with the black color largely opaque, shining only near the incisures, fourth segment black with a distinct interrupted, gray pollinose band *groenlandicus* O Fabr
6 Hind tibia with the yellow color more extensive than the black, hind femur yellow on nearly the apical third *pendulus* Linnæus
Hind tibia with the black color plainly more extensive than the yellow, hind femur with a yellow preapical band not over one fifth as wide as the length of the femur 7
7 Abdominal segments three and four with the posterior margins orange thoracic stripes prominent and uniform *hybridus* Linneaus
Abdominal segments three and four with the posterior margins shining black, thoracic stripe narrow, broken or varying in width on posterior half *obscurus* Loew

8 Male abdomen with a yellow elongate spot, triangular in form, on each side of the second segment, female abdomen with elongate, curved, gray spots on either side of third and fourth segments not in contact with the lateral margins *bilinearis* Williston
Both sexes with interrupted cross-bands on each of abdominal segments two, three and four, in contact with the lateral margins 9
9 Female abdomen with the posterior margins of segments three and four gray pollinose, male hind femora black at base *lunulatus* Meigen
Female abdomen with posterior margins of segments three and four shining, male hind femora yellow at base *hamatus* Loew

Helophilus borealis Staeger

In the Canadian Entomologist for 1897, Hunter published a description of *Helophilus dychei* from Williston's manuscript The type specimens were procured at Sitka, Alaska, by Prof L L Dyche I found the same species very plentiful at Kodiak and at Savonoski and procured a hundred or more specimens, fifty of which were pinned and kept for future study In pinning these specimens all variations observed were selected and as the species proved to be a variable one the series furnishes an interesting study The smallest specimen is nine millimeters in total length, while the largest one is nearly fifteen millimeters About two-thirds of the specimens show no gray markings on abdominal segments two, three and four, while the other third show these markings plainly The thoracic stripes are somewhat more prominent in some specimens than others, although these stripes are not prominent in any of the specimens Even there is variation in the face which in some specimens is more prominent than in others

Like many northern species, we would expect naturally that this one would extend entirely across the American Continent, and such is the case, for specimens from northern Maine and Mount Desert, Maine, as well as from some eastern localities further north, cannot be separated by any constant characters when long series are considered In comparing Johnson's material of fifteen specimens above mentioned, labelled glacialis, borealis and dychei, with Alaskan material, it was possible to duplicate from the latter every specimen included in the former

Both *Helophilus borealis* Staeger and *Helophilus glacialis* Loew are fully characterized in Williston's Synopsis of North American Syrphidæ and fully compared with *Helophilus groenlandicus* Otto Fabricius, but not with one another The latter species is quite distinct and easily identified, but my studies indicate that the former two names are synonyms They are applicable to specimens with gray bands on the third and fourth abdominal segments, while *Helophilus dychei* Williston and *Helophilus bruesi* Graenicher refer to those specimens that lack these gray bands As has been stated, some specimens show gray abdominal bands and some do not In a series of six selected for the purpose these bands are prominent on number one and gradually become less evident until in number six they are wholly lacking, even with high magnification, yet otherwise all the specimens are of the same size, appearance and coloration

Since borealis is the oldest name, it stands as the name of the species and *glacialis* Loew, *dychei* Williston, *bruesi* Graenicher, and I believe *androclus* Walker are synonyms of it

The species has a wide distribution in North America, but I can find no record which would indicate that it is a member of the European fauna It has been reported from Greenland, Labrador, New Foundland, Maine, Canada, Colorado, New Mexico and Wisconsin In the southern parts of its range it occurs at high altitudes

Helophilus groenlandicus Otto Fabricius

Helophilus groenlandicus is very easily separated from borealis when specimens are at hand, but it is rather difficult to write out directions for the purpose By using the accompanying key carefully the student should obtain the proper result As it was named at an early date from Greenland, and as it occurs also in Northern European countries, no great surprise attaches to the fact that it has been given at least two additional names by old world dipterists In Kertesz, Catalogue, *Helophilus arcticus* Zetterstedt and *bilineatus* Curtis are accepted synonyms, while Williston believes that *latro* Walker refers to the same species Besides there is no very good reason for excluding *chalepus* Walker from the same synonymy

Common at Savonoski, Alaska, where I observed many specimens and pinned nearly forty I have seen specimens from Isle Royale, Michigan, Labrador, and New Foundland Others have reported it from Greenland, Lapland and Europe Specimens that I have studied are very uniform in coloration, in which respect it differs from the previous species

Helophilus obscurus Loew

Abundant at several stations along Naknek Lake, Alaska, in July, 1919 More than a score of specimens taken The hind femur is nearly all black, only a narrow, more or less obscure preapical band yellowish Median thoracic stripes more or less irregular and broken, an interrupted band on each of abdominal segments two, three and four Fluke gives a full description of the species in his Syrphidæ of Wisconsin Specimens are at hand also from Chippewa and Alger counties, Michigan, belonging to the University of Michigan Museum, and from Orillia, Ontario It has been reported from Colorado, Wisconsin and Wyoming

Helophilus pendulus Linn

Plentiful at Savonoski, Alaska, in July and August, 1919 It is a common European species, but has not been reported from America heretofore My specimens were compared with European examples in the United States National Museum and agree perfectly, except there is not so much black on the apical third of the hind tibia in Alaskan specimens Somewhat similar to *obscurus*, but the thoracic stripes are very distinct, the hind femur has the apical third yellow and the hind tibia is more than half yellow Kertesz' Catalogue gives *praecox* Rossi, *similis* Curtis, *trilenva* Harris, *trilineata* Harris and *trivittata* Meigen, all names given in Europe, as synonyms

Helophilus hybridus Loew

Very much of the appearance of *Helophilus similis* Macquart, but known at once from that species by the shining black stripe on the face First recognized from North America in 1847 by Macquart when he described *Helophilus novae-scotiae* from the country after which it was named *Helophilus latitarsis* Hunter, described in the Canadian Entomologist for 1897, from Minnesota, constitutes the second published record for America for Hunter's name is surely a synonym

The material of hybridus before me consists of five specimens, a female from Caledonia, North Dakota, July 30, 1918, and a male and female from Banff, Alberta, July 17, 1902, R C Osburn, collector, a male from Fargo, North Dakota, May 27, 1917, P W, Fattig, collector, and a male from Turtle Mountains, North Dakota, August 6, 1920, T H Hubbell, collector

Helophilus trivittatus Fabricius

This European species has been reported from the city of Mexico and Verrall published the opinion that *Helophilus latifrons* Loew, which has long been considered peculiar to America is a synonym, but later Becker announced the opinion that the two are separate

When it is considered that a long series of specimens shows variations and also that so many related species are common to Europe and America, there are good reasons for accepting Verrall's conclusion, and his view is strengthened when one compares the specimens and descriptions available

Kertesz in his catalogue, following Verrall, places *latifrons* Loew in synonymy with *trivittatus* Fabricius and also includes the European names *camporum* Mg and *parallela* Harris Hunter reports *latifrons* from Cook Inlet, Alaska, so it occurs over a wide range in America

Helophilus similis Macquart

The shining facial stripe is yellow or brown, the front in the male is narrow, in the female wide and almost wholly black pilose Widely distributed over North America, but not known from Europe Chas R Jones records it from England, but he writes that this is an error Walker's names *decisa* and *fasciata* and Jaennicke's *susurrans* are admitted as synonyms in all recent lists

Helophilus lunulatus Meigen

The species of the genus *Helophilus* closely related to *lunulatus* are difficult to separate The sexes of each species are different, and often it is the case that one sex or the other of two species has fairly good distinguishing characters, but the opposite sex practically is without anything of the kind Coquillett definitely reported *lunulatus* from Alaska in 1900 Before that date it was considered strictly European, but since it has been mentioned in several local lists and from various parts of the United States In every case descriptions in this group of species in North America have been taken from a single specimen Loew described *hamatus* and Hunter *pilosus* from females, and Williston had the male when he described *bilinearis* Because of this, one cannot depend fully upon many of the comparisons that have been made up to the present

Both Verrall and Lundbeck have furnished full descriptions of both sexes of *lunulatus* and have pointed out that in the female the hind margins of the abdominal segments are covered by gray pollinose bands, while the descriptions of both *hamatus* and *pilosus* mention these same parts as shining Among my material I find no specimens that show the gray posterior bands on the abdominal segments, except a series of females taken at Savonoski, Alaska These with the males associated with them in the field, answer the description of *lunulatus* in detail and I believe should be considered as that species

Almost all the various species near *lunulatus* appear on the wing in early spring I have taken what I consider *bilinearis* from spring beauty, *Claytonia virginica*, which is a well known early spring flower Specimens of other species taken in Ohio, Indiana, Michigan and Wisconsin bear date of early May It appears that they are not so rare if looked for at the proper season Since there are so few specimens in the collections of the country, some careful early spring collecting and field observations are very much needed

Helophilus laetus Loew

Loew described four nearly related species of *Helophilus* in succession in Centuria IV Since *laetus* is the commonest species the group is often known as the *laetus* group It is interesting to note that the ocelli are practically as remote from each other as in *Asemosyrphus*, a genus which has been split off from *Helophilus* mainly on account of that character These species all were described from the female sex and from a limited number of specimens, consequently they have given dipterists more or less trouble and even doubt has been expressed occasionally as to the distinctness of some of them At last it has been possible to associate the sexes of all four and establish their validity Practically every published list of Syrphidæ in the country records *laetus*, so it has a wide distribution Loew's description must not be taken too literally, however, for a series of specimens shows quite a range of variations in color markings of legs and abdomen Hunter finds by a study of the type that *Helophilus aureopilus* Towns is a synonym

Helophilus divisus Loew

On page 138 of Volume 29 of the Canadian Entomologist, Dr W D Hunter has characterized this species The male, although quite variable in coloration of body and legs, may be known among American species of its genus by the prominent tubercle on the under side, near the base of each hind femur *Helophilus frutetorum* Fabr of Europe, has even a more prominent tubercle similarly located In a series of six males, no two have the body markings alike There is variation also in a series of four females Loew described a female and a translation of his description is given in Williston's synopsis The sexes agree in possessing a narrow median pollinose mid-dorsal thoracic stripe, attenuated at both ends and dividing the median black thoracic stripe From profile view the face is short and very little excavated beneath the antennæ Specimens from Sandusky, Kent, Columbus and Medina, Ohio, Westville, New Jersey, Winona Lake, Ind , Lake City, Florida, and Berrien County, Michigan Loew's type was taken in the District of Columbia

There is good reason for considering *Helophilus flavifacies* Bigot, a synonym of *divisus* Bigot's specimen was taken in Maryland, and I have a specimen which answers his description in detail

Helophilus integer Loew

The male of this species may be known, so far as my specimens show, by the front being entirely bright yellow haired and plainly narrower above than in *divisus*, *laetus* and *obsoletus*, the only species with which it is easily confused The female corresponds with the male in having very bright yellow thoracic stripes, but the front is extensively black pilose It is likely a long series of specimens would show much variation in the color markings of legs and abdomen Specimens from Massachusetts and New Jersey

Helophilus obsoletus Loew

Both sexes may be known by the obsolete median thoracic stripes and the slender hind femora Loew described the female and the description is translated by Williston for his synopsis What I consider the male of *obsoletus* is in the University of

Michigan Museum from Isle Royale The upper half of the front is black and black pilose The abdomen is largely black with a widely interrupted yellow band on each of segments two and three and an interrupted gray band on four Each of segments three and four also have a gray mid-dorsal triangle posteriorly and both of these segments have something of a yellow posterior margin in connection with the triangle, femora black, yellow apically, front tibia yellow basally and blackish on apical half, front tarsi and middle tibiæ and tarsi largely yellow, hind tibiæ black, each with a narrow basal and broader median band yellow, hind tarsi mostly black on superior side and mostly yellow otherwise I doubt if color markings of legs and abdomen are constant enough in a series of specimens to be dependable for specific distinction Three females from Whitefish Point, Michigan, collected by McAlpin and Andrews, and a male from Isle Royale extend the known distribution of *obsoletus* much southward for the only published record heretofore gives the species as coming from Fort Resolution, Hudson Bay Territory

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A USEFUL CAGE FOR THE REARING OF SMALL INSECTS ON GROWING PLANTS*

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In the rearing of aphids and their parasites, and scale insects for the past two years, the writer has found a specially designed cage of sheet-celluloid very satisfactory Such a cage was made necessary from the unsatisfactory use of the standard lantern globe cages for rearing aphids, and other larger screen cages in common use for rearing insects on growing plants

While sheet-celluloid has long been used by entomologists in various ways for rearing cages chiefly to enclose portions of plants outdoors, so far as the writer has been able to learn, nothing has been published regarding it Some time ago Mr J J Davis, of Perdue University, who has been engaged in collecting data for a book on rearing methods, was asked to verify this assumption He replied that his records disclosed no publications on the use of celluloid in the construction of rearing cages, although they had used it in Indiana for some time, but not the type of cage the writer had designed Without claiming any originality for the idea for the use of this material in rearing cages, the writer believes it desirable to place on record his experience with it, especially in the type of cage discussed below which he believes to be different from those in common use

Any cage for rearing insects under normal, natural conditions, must provide for the same conditions of light, temperature and moisture within the cage as those which appear in the surrounding outside habitat, or as near these conditions as possible In other words, the cage must allow for a free circulation of air, permit the entrance of the maximum amount of light, and not cause a condensation of heat or moisture Still another feature bears considerable importance when dealing with small insects, and that is the absence of any cracks or niches in which the insect may hide or escape

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[*] Contribution No 44 from Dept of Forest Entomology, New York State College of Forestry, Syracuse N Y

Lantern globes, so commonly employed in rearing aphids and other small insects, were extensively used in the above rearings, but under conditions of direct sunlight and higher temperature so often encountered during the spring and summer months, they were found to overheat and "sweat" so badly as to be practically useless In casting about for a cage that would remedy the faults found in glass and still possess the other desirable features, one was constructed out of sheet celluloid, which satisfied the requirements

The simplest and most suitable form of cage is the cylindrical type made by bending together the edges of a rectangular piece of celluloid and sealing them with 95% alcohol † Ventilation holes of any size and position on the sheet, may be cut in before bending After the edges are sealed together and the cylinder is formed, the ventilation openings and one end opening are covered with fine cheese-cloth or voile, shellaced on the celluloid around the edges of the openings The cage is now ready to be placed over the plant, usually a small one in a pot In order to hold the cage securely in position and provide a smooth white surface on the bottom of the enclosure about the plant, melted paraffine is poured on the soil around the plant, and the open end of the cage set down into it after the edges have first been given a thin coat of vaseline to prevent the adherence of the paraffine Thus treated the cage may be lifted free when the paraffine cools, leaving a smooth tight groove into which the edges just fit and prevent the escape of any insect when the cage is in place

In addition to the type of cage described above, the writer has found sheet celluloid a very satisfactory material with which to construct exceptionally small cages for a portion of a plant like a small twig, or a part of the surface of a leaf or fruit on which it is desirable to confine small sedentary insects such as scales and aphids In these small cages, ventilation may be secured by punching small holes in the celluloid with a fine needle Shellac was found useful in joining together the sharp edges of the cage and sticking it to the plant surface This material soon drys, with a hard surface so that it will not entangle the insects, and yet remains soft enough to prevent cracking and breaking apart

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†Suggested by Mr Larrimer of Indiana

Cages thus constructed from sheet celluloid possess the following desirable features

1 They are as transparent as glass, and do not "sweat" or concentrate heat like the glass cages

2 With this material they can be made any size and shape desired

3 They may be ventilated by cutting any number and size of openings in the side

4 The completed cage is very neat and smooth within, making it easy to observe specimens at all times

5 Entry for the introduction or removal of material is easily made by tearing back a corner of the cloth ventilator, or lifting up the cage from its paraffine base

The undesirable features are

1 Cost in material and time for making

2 Possible deterioration on exposure to the elements This defect was called to the writer's attention by Mr J J Davis in a private communication Automobile owners also complain of this rotting of the celluloid in their curtains However, in the writer's experience with the material used in rearing cages, often under most unfavorable conditions of heat and moisture, he has found no such deterioration

These many advantages possessed by celluloid have caused the writer to regard it with much favor as a material for solving the difficult problems of a suitable cage for small insects on growing plants He hopes that the publication of this short article will bring the material to the attention of others who may have overlooked its great usefulness in cage construction

Recieved for Publication, January, 12, 1923

SOME NOTES ON AMERICAN TABANIDÆ WITH THE DESCRIPTION OF A NEW SPECIES FROM AFRICA

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Genus Pronopes Loew

This genus was described by Loew in 1857 for the reception of a single species, nigricans, which he described from a single male specimen from the Cape of Good Hope A little later in his Dipterous Fauna of South Africa he further characterized the genus and published several drawings I am able to find no further record of additional specimens, but the genus has been mentioned in several publications since

The genus is characterized by the male having the eyes widely separated and long pilose, body short and wide, ocelli present, third segment of the antenna of five subdivisions of which the first is large and ovoid, spines at the end of the hind tibia small and rather easily overlooked

Recently I received from Dr A L Melander, two males and a female collected by Dr Brauns at Willowmore, South Africa, January 20, 1904 The female appears quite different from the males on account of being much larger and more robust and differently colored but agrees exactly in the characters enumerated for the genus above

Pronopes nigricans Loew is described as black with grayish black wings with blackish nerves arranged as in the genus Tabanus The specimens before me, although they belong to the genus without doubt, appear to belong to a different species

Pronopes flavipes n sp

Male, thorax mainly black, gray pollinose and pilose, wings yellowish hyaline, legs yellow, blackish near the joints, abdomen yellow Length seven millimeters

Female, thorax, wings and legs as in the male, abdomen dark with conspicuous light posterior margins to the segments Length eight millimeters

Male Face and front nearly as wide as either eye, gray pollinose, nearly black pilose, pile at vertex abundant and long, ocelli prominent, located as is usual for females in the subfamily, antenna dark short first segment enlarged, rounded, second segment much smaller but rounded, third segment of five subdivisions of which the basal is much the largest evenly convex above and slightly convex below Remaining four rings small, apical ones narrowed, palpi very small, yellow proboscis short black, eyes sparsely long pilose Thorax dark, gray pollinose and rather long pilose, a narrow shining middorsal stripe slightly widening towards the scutellum which is of the same color as the stripe on the disc but the margin is gray pollinose Wings yellowish hyaline, small stigma dark, venation normal, anal cell closed, all the posterior cells open, no stump on the anterior branch of the third vein legs yellow, knees, tips of tibiæ and apical tarsal segments nearly black Abdomen mostly bright yellow, first segment very largely black below and above but sides above broadly yellow, second segment with a large black middorsal spot Extreme tip of abdomen slightly infuscated Actual width of abdomen at widest place about two and one-half millimeters Actual width of front at narrowest point more than one-half millimeter

Female Exactly like the male except in the following particulars Front wider than either eye, actual width at narrowest place one millimeter Abdomen dorsally dark colored, first segment with a narrow, somewhat irregular posterior light border, second segment dark at base, posterior light border about one-third as wide as the length of its segment, expanded into a triangle at middle, remaining segments with the posterior gray borders wide and beyond the third including most of the segments Venter yellowish gray pollinose all over

Type male, allotype female and one paratype male from Willowmore, Capland, January 20, 1904, collected by Dr Brauns

Tabanus equalis n name

For Tabanus uniformis Hine, OHIO JOURNAL OF SCIENCE, Volume 17, page 270, 1917 There is an earlier Tabanus uniformis by Ricardo, Records Indian Museum, Volume 4, page 218, 1911

Chrysops mœrens Walker

Walker described the species from Nova Scotia Chrysops æstuans Vander Wulp named from Wisconsin is considered a synonym Recent work by various collectors has extended the known range nearly to the Pacific Coast and it should have been included in my paper on Tabanidæ of Western United States and Canada Some Western specimens, although not all, are unusually large, but specific characters agree with those of Eastern specimens

The species has been taken at Hermiston, Oregon and Lowden, Washington, by Melander, at Lake Paha, Washington, by Shannon, at Rittsville, Washington, by Lane, and at Grand Coulee, Washington, collector not given

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A DUCK WITH WEBLESS FEET

JOHN H SCHAFFNER
Ohio State University

During the summer of 1921 there was hatched on the farm of Mr Louis Weiss, near Morganville, Kansas, a duck which appeared normal in every respect except that the feet had no indication of a web The owner had a flock of over fifty white ducks of various ages, all having the normal webbed feet except the duckling under consideration

The toes of the duck are rather long and the prominent web is apparently an aid in walking as well as swimming, since this mutant duck showed some difficulty in running as compared with the normal individuals When placed in a tank, it floated about, kicking its feet violently in the water, but made rather slow progress as compared with a normal, web-footed companion

The duck was a female and grew to maturity, but died at the development of her first egg, which was broken in the oviduct The writer had planned to carry on breeding experiments to determine the true nature of this remarkable character Unfortunately, not even the feet were preserved The owner of the duck, Miss Idella Weiss, and other members of the family reported that this duck developed exceedingly long claws, over two inches long, which interfered greatly with walking The writer did not see the animal after the duckling stage, but there is no question as to the reliability of the reports on the long-clawed character It is to be hoped that if a similar mutation appears at some other time or place the animal will survive, that test may be made to determine the hereditary peculiarities of the character

The accompanying photograph, although made with a "Brownie" camera, shows the nature of the feet fairly well There is less web between the toes than in an ordinary chicken This mutation appealed to the writer as an unusual oddity, for here is a bird that lost, at a single jump, one of the characteristics essential to its normal mode of life and instincts

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REPORT OF THE THIRTY-THIRD ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The Thirty-third Annual Meeting of the Ohio Academy of Science was held at Oberlin College, Oberlin, March 30 and 31, 1923, under the Presidency of Professor Albert P Weiss Fifty-five members were registered as in attendance, twenty-five new members were elected

The annual excursion of the Section for Geology was held on May 25, 26 and 27, under the general management of Professor J Ernest Carman, Vice-President for 1923–24 The party gathered fifty strong at Newark, Ohio The first day was devoted largely to archeology, in the study, under the guidance of Dr W C Mills, of the earthworks near Newark and the flint quarries of Flint Ridge Mr Wilber Stout directed the remainder of the trip, which was planned for the observation of the Pennsylvanian and Permian rocks, the Quaternary molding sand deposits, and the topography of Muskingum County

GENERAL PROGRAM

FRIDAY, MARCH 30

9.30 A M—Business Meeting
11 00 A M—Reading of Papers in General Session
12.30 P M—Luncheon
2 00 P M—Illustrated Lecture by Professor Henry C Cowles, of the University of Chicago, on "Trees as Witnesses in Boundary Disputes, and Instance of Applied Ecology"
3·00 P M—Reading of Papers in Sectional Meetings
6.30 P M—Dinner
8·00 P M—Address by the President of the Academy, Professor Albert P Weiss, of Ohio State University, on "The Aims of Social Evolution"

SATURDAY, MARCH 31

9 00 A M —Adjourned Business Meeting
10 30 A M —Reading of Papers in General Session
12.30 P M —Luncheon
2 00 P M —Demonstrations
2 30 P M —Reading of Papers in Sectional Meetings

FRIDAY, MAY 25, TO SUNDAY, MAY 27

Excursion of Section for Geology, Muskingum County

MINUTES OF BUSINESS MEETINGS

The first business session was called to order by President Weiss at 9 30 A M , on Friday, March 30, an adjourned session was held at 9·00 A M on the following day

The appointment of the following committees for the meeting was announced by the chair

Committee on Membership—W M Barrows, Lynds Jones, E L Fullmer

Committee on Resolutions—C H Kennedy, R C Osburn, G D Hubbard

Committee on Necrology—T C Mendenhall

The following *Auditing Committee* was elected by the Academy Stephen R Williams, M M Metcalf

The following *Nominating Committee* was elected by the ballot of the Academy R C Osburn, E Lucy Braun, G D Hubbard, T C Mendenhall, C G Rogers, A P Weiss

Report of the Secretary

The following report by the Secretary was received and ordered filed

March 30, 1923

To the Ohio Academy of Science

The work of the Secretary for the last year has been almost entirely routine The following items may be reported for the sake of record

A brief report of the Thirty-second Annual Meeting was sent to *Science*, and appeared in the number for September 8

The Secretary was present to represent the Academy in the Council of the American Association for the Advancement of Science at the Boston Meeting

The certificate of election to fellowship has been mailed, as directed by the Academy, to the fellows elected in 1920 and 1921, as well as to those elected in 1922

Respectfully submitted,
EDWARD L RICE, *Secretary*

Report of the Treasurer for the Year 1922-1923

The report of the Treasurer was received as follows and referred to the Auditing Committee, whose report is appended

RECEIPTS

Balance April 12, 1922, as previously reported	$ 617 52	
Librarian's sales of publications, 1921–1922	37 00	
Librarian's sales of publications, 1922–1923	23 45	
Membership dues, A A A S and the Ohio Academy	1,311 00	
Total receipts		$1,988 97

DISBURSEMENTS

American Association for the Advancement of Science	$693 00	
The Ohio Journal of Science	350 00	
Spahr and Glenn, printing	75 00	
E I Rice, Secretarial expenses	33 10	
Independent Print Shop	45 50	
Lynds Jones, for expenses, executive committee	12 32	
B V Bevin	2 00	
Eunice Evans, stenographic work	10 00	
Returned check	2 00	
Total disbursements		$1,222 92
Balance on hand, 1922–1923		$ 766 05

A E WALLER, *Treasurer*

The accounts herewith and vouchers checked over and found to be correct

STEPHEN R WILLIAMS,
MAYNARD M METCALF,
Auditing Committee

The following financial statement of Mr L H Tiffany, manager of the Ohio Journal of Science, while not strictly a part of the Treasurer's Report, is appended for the information of the Academy

FINANCIAL STATEMENT OF THE OHIO JOURNAL OF SCIENCE
(Volume XXII, 1921–22 The Ohio Journal of Science)

RECEIPTS

Ohio State University Allowance	$500 00	
A E Waller, Treasurer, Ohio Academy of Science	250 00	
Reprints, extra copies of Journal	218 40	
Total receipts		$968 40

EXPENDITURES

Bucher Engraving Company	$ 58 18	
Stenographic Work	3 50	
Postoffice Deposit	3 89	
Stamps, mailing and stationery	64 47	
Total expenditures		$130 04
Balance on hand 1921-22		$838 36
Estimated cost of the Journal, 1921-22		$1,000 00
Cash on hand, 1921-22		838 36
Deficit for 1921-22		161 64
Deficit for 1920-21		447 31
Total deficit		$ 508 95

Report of the Executive Committee

The report of the Executive Committee was received as follows and ordered filed

March 30, 1923

To the Ohio Academy of Science

A meeting of the Executive Committee was held in Columbus, October 21, 1922 All members were present

At this meeting the invitation to hold the Thirty-third Annual Meeting at Oberlin College was accepted, and the meeting was set for March 30 and 31

The Secretary was instructed to arrange, if practicable, for the publication in the Ohio Journal of Science of a brief obituary notice of Mr Emerson McMillin, in anticipation of a more adequate memorial to be presented at this meeting The late appearance of this notice (in the January-February number) was unavoidable, because of the readjustment of the dates of publication of the Journal

The Secretary presented a letter of June 10 from President Charles D Walcott, of the Spencer Fullerton Baird Memorial, announcing plans for the celebration of the one-hundredth anniversary of the birth of Spencer Fullerton Baird, February 3, 1923, and inviting the Academy to designate a representative on the national committee The letter closes with these paragraphs

> Among the suggestions that have been made for a permanent national memorial are (1) a bust, statue, mural or open-air fountain, or bronze mural tablet to be provided by voluntary subscriptions and erected in the grounds of the Smithsonian Institution or the National Zoological Park, and (2) a fishery museum or exhibit, with public aquarium, embracing both the scientific and applied features of fishery problems, to be established by Congress under the auspices of the Smithsonian Institution
>
> "It has been suggested also that there be established a Baird Memorial Medal to be awarded periodically to persons performing noteworthy original or meritorious work in science, and that there be published during 1923, preferably under the auspices of the National Museum or the Smithsonian Institution, a memorial volume to be made up of original papers on scientific subjects contributed by Baird's associates, colleagues, and immediate followers

"In advising me that your organization will be represented on the national Baird memorial committee, will you kindly communicate your views on the general subject of the memorial?'

The action of the Executive Committee is shown in the following quotation from the reply to Dr Walcott's letter

"Our committee was enthusiastically in favor of such a memorial and appointed Dr Raymond C Osburn, of Ohio State University, as our representative As to the particular form of memorial, the consensus of opinion was in favor of the fountain or aquarium, rather than the other alternatives suggested in your letter Dr Osburn was, however, left without formal instructions."

On the suggestion of the Treasurer, it was voted to allow to each new member the option of receiving the back numbers of the Ohio Journal of Science from January to the time of election or of commencing the Journal with the following January, as he may prefer

A second meeting of the Committee was held in Oberlin on March 29, 1923 All members present

In accordance with the instructions of the last Annual Meeting, the Committee has prepared a series of amendments to the Constitution, establishing the Committee on State Parks and Conservation as a standing committee of nine members, and providing for the election of three members each year for a term of three years These amendments will be presented for adoption later in the session The expiration of the term of office of the committee membership was determined by lot, as follows Herbert Osburn, Chairman, 1925, E Lucy Braun, 1924, J E Carman, 1924, Bruce Fink, 1926, E L Fullmer, 1925, E R Hayhurst, 1926, F H Herrick, 1925, C G Shatzer, 1924, E N Transeau, 1926

The Committee voted to recommend that the Academy heartily endorse the efforts of the Ohio College Association toward the securing of uniformity in date of the spring vacation of the colleges of Ohio, as facilitating attendance at meetings of the Ohio College Association, Ohio Academy of Science, and other societies consisting largely of college men

The Committee also voted to recommend to the Academy an amendment of the By-Laws providing an annual honorarium of one hundred dollars for the Secretary, this honorarium to include expenses for clerical assistance

Sixteen applications for membership have been approved, subject to final ratification by the present meeting

Respectfully submitted,

EDWARD L RICE, *Secretary*
For the Committee

Report of the Publication Committee

The following report of the Publication Committee was received and ordered filed.

The Annual Report of the Thirty-second Meeting, Proceedings, Vol. VII, Part 7, contained 36 pages and was published March 1, 1923

The report minus the membership list was also published in the Ohio Journal of Science 23 1-24, 1923

Respectfully submitted,
H C SAMPSON, *Chairman*

Report of the Library Committee

The following report of the Library Committee was received and ordered filed

March 29, 1923

To the Ohio Academy of Science

The Library Committee begs to report that all the duties devolving upon it have been discharged as promptly as possible

The sale of publications during the year amounted to $23 45 This amount has been turned over to the Treasurer of the Academy

The Proceedings of the Thirty-second Annual Meeting, 1922, were received from the printer on March 12, 1923 Copies were mailed immediately to all persons on the membership roll, and to all institutions on the exchange list

The publications which have been received on exchange have been added to the others previously filed in the University Library The University Library would like to see more use made of these exchanges and other scientific sets by the members of the Academy who are non-resident in Columbus The University Library annually renews its offer to lend to the members of the Academy, through their home libraries, the scientific publications needed in their research work

The writer of this report desires to call the attention of the Academy to Section 3 in House Bill No 400, "A bill relative to state recognition of the Ohio Academy of Science" now before the 85th General Assembly On page 2, lines 28, 29 and 30, read as follows "All exchanges received shall be kept available to the citizens of the state through the Ohio State Library, or such other channel as may be determined" While not wanting to say anything to affect the cordial relations existing between the Ohio State Library and the Ohio State University Library, yet be it said that if an individual library is to be specified in the bill, it ought to be the library which is at present, and has been for eight years handling the exchanges of the Academy, namely the Ohio State University Library If the bill should be made to read that exchanges were to be kept at such a place as may be determined by the Academy, no objection could be made, because the question of the disposition of its property is a right inherent in the organization

Furthermore, it may not be known to the members of the Academy, but the facts are that the State Library and the University Library are dividing the field between the two institutions, whereby the technical and scientific literature is to be developed by the University Library In accordance with this plan, it would naturally fall to the University Library to handle and make available any scientific literature received by the Academy

Section 3 of this bill also needs redrafting, especially as it relates to the distribution of the publications of the Academy As drafted it provides that one copy of the Proceedings shall be sent to each public library and museum, university, college, normal school and first grade high school It also provides that one copy of the Ohio Journal of Science shall be sent to each university and college Then, it provides that "not less than one hundred copies of each publication shall be distributed through the Ohio State Library" Since the provision is made specifically for the distribution of the publications, to whom is the State Library to send its one hundred copies?

Furthermore, the Academy does not control the Ohio Journal of Science If such is the case, can this bill, which relates to the Academy, provide for the distribution of the Journal, for the handling of its exchanges, and for grant of one hundred copies to the Ohio State Library?

The Ohio State University has been paying to the Ohio Journal of Science $500 00 a year, for which sum 250 copies of each issue have been allotted the University Library for exchanges Under the proposed legislation, some complications are likely to occur if such exchanges are to be deposited in the Ohio State Library

These statements are made with the friendliest of feelings, but with the purpose of pointing out some features in Section 3 which need more study, in order to keep the Academy from difficulties into which it may unknowingly place itself

This bill was introduced into the House by Mr Riggs on February 21st, was read the second time on February 28th, and then referred to the Committee on State and Economic Betterment It was reported out on March 23d

If the Academy feels that these points are of importance, it may be proper to instruct its Legislature Committee to seek the desired changes in the bill, either as amendments on the floor, or in the Senate committee, should the bill pass the House

Respectfully submitted,
By C W REEDER,
For the Library Committee

Report of the Trustees of the Research Fund

The following report of the Trustees of the Research Fund was received and referred to the Auditing Committee, whose report is appended

To the Ohio Academy of Science

The Trustees of the Research Fund submit the following Report for the period from March 29th, 1922, to March 30th, 1923

RECEIPTS

Cash on hand March 28th, 1922	$1,090 20	
Interest on bonds	36 12	
		$1,126 32

EXPENDITURES

May 8th, 1922, Postage	$ 2 00	
June 12th, L B Walton	35 80	
July 24th, Francis H Herrick	99 75	
August 19th, L H Tiffany	47 71	
September 16th, James E Kindred	75 00	
December 8th, E L Stover	16 20	
March 13th, 1923, Raymond A Dobbins	26 30	
		$ 302 76

ASSETS

Cash on hand March 29th, 1923	$823 56	
Liberty Bonds at par	600 00	
		$1,423 56

LIABILITIES

Balance on grants to		
L H Tiffany	$ 2 29	
R A Dobbins	73 70	
E L Stover	33 80	
Francis H Herrick	25	
		$ 110 04
Excess of cash assets above liabilities		$ 713 52

Vouchers are submitted herewith

T C Mendenhall, *Chairman*,
Geo D Hubbard,
Herbert Osborn,
Trustees

Books audited and found correct

Stephen R Williams,
Maynard M Metcalf,
Auditing Committee

Report of the Committee on State Parks and Conservation

The following report of the Committee on State Parks and Conservation was received and ordered filed

To the Ohio Academy of Science

Your Committee can not report any very extensive activity during the past year, but there are several matters of interest which it will be proper to mention

The final acquisition and dedication of the Roosevelt Park in southern Ohio establishes an extensive and very desirable tract as a permanent game refuge in which we can be assured of the preservation of the natural conditions, and it would appear a very satisfactory arrangement for control between the Fish and Game Commission and State Forester, both of whom, no doubt, will accept suggestions concerning biological features that may be of service

Under the Silver Bill the State Forester has secured additional tracts for State Forestry purposes, and these, of course, are distinct advances in the matter of preservation of the native flora and fauna

The present Legislature has enacted or will probably enact a Bill accepting the Bryan farm near Yellow Springs, a tract of something over 500 acres, which was given to the State for preservation as a game refuge, and experiment farm, and under the conditions provided in the present act, will doubtless furnish an additional valuable tract for the preservation of natural conditions

The transfer of a tract of fifty-seven acres, including the Harness Mounds from the United States Government to the State, under the control of the State Archeological Society, gives us another interesting tract as a public park

Failure of the National Congress to pass the bill to provide for national game reserves, which would have made possible the preservation of swamp areas and other suitable breeding grounds for migratory fowl, makes it, of course, more desirable that the State should set aside a number of such tracts within our boarders for the purpose of conserving wild life dependent upon such conditions It seems therefore that one of the early movements of the Academy should be to secure, through the Fish and Game Commission or such other channel as may be available, certain reservations of this character

The waterways project now being considered by the National Government, which would provide a waterway from the Lake to the Ohio River, is a matter of very distinct interest to the members of the Academy, especially in reference to its features of conservation and utilization of water resources in the State Such a waterway with its reservoir system would make some very important additions to the water areas and utilization, and your Committee will endeavor to keep in close touch with progress in this line

Respectfully submitted,

Herbert Osborn, *Chairman*,
Francis H Herrick,
E N Transeau,
J Ernest Carman,
C G Shatzer

Report of the Committee on Legislation

The following report, presented by the Committee on Legislation, was received as a report of progress, and the Committee was continued In view of the questions raised in the Report of the Library Committee with reference to the bill for State recognition of the Academy, Mr Reeder was added to the Committee on Legislation

The Committee is able to report that a bill for the recognition of the Ohio Academy has been introduced in the Legislature, and two members of the Committee had a conference with the Committee to which the bill was referred. It received a very cordial consideration, and so far as this Committee is concerned, it appears that the bill will have cordial support Just what fate it may have in the House we cannot say Furthermore, the bill will have to be acted upon by the Senate, and considering the lateness of the session we are somewhat in doubt as to the outcome

The bill as drafted was changed in two particulars from the bill as agreed upon in the Academy, but the changes made, we believe, will not defeat the objects of the proposed relation to the State If passed, it should enable the Academy to extend its usefulness and to secure modifications if necessary in the future

We recommend that the Committee be continued or a new Committee appointed with authority to adjust the constitution and make any arrangement of details necessary in the carrying out of the provisions of the bill

Respectfully submitted,
HERBERT OSBORN, *Chairman*,
T C MENDENHALL,
W H ALEXANDER,
EDWARD L RICE,
MAYNARD M METCALF

Election of Officers

The following officers and committee members for 1923-24 were elected by the ballot of the Academy

President—Professor K F Mather, Denison University, Granville

Vice-Presidents

- *Zoology*—Professor W M Barrows, Ohio State University, Columbus
- *Botany*—Professor H H M Bowman, Toledo University, Toledo
- *Geology*—Professor J E Carman, Ohio State University, Columbus
- *Physics*—Mr W C Devereaux, U S Weather Bureau, Cincinnati
- *Medical Sciences*—Professor B M Patten Western Reserve University, Cleveland
- *Psychology*—Professor H A Aikins, Western Reserve University, Cleveland

Secretary—Mr W H Alexander, U S Weather Bureau, Columbus

Treasurer—Dr A E Waller, Ohio State University, Columbus

Elective Members of Executive Committee—Professor A P Weiss, Ohio State University, Columbus, Professor E L Rice, Ohio Wesleyan University, Delaware

Member of Publication Committee—Professor L B Walton, Kenyon College, Gambier

Trustee of Reserach Fund—Professor Herbert Osborn, Ohio State University, Columbus

Member of Library Committee—Professor F O Grover, Oberlin College, Oberlin

Representatives on Editorial Board of Ohio Journal of Science

Zoology—Professor R A Budington, Oberlin College, Oberlin
Botany—Professor Bruce Fink, Miami University, Oxford
Geology—Professor G D Hubbard, Oberlin College, Oberlin
Physics—Professor S J M Allen, University of Cincinnati, Cincinnati
Medical Sciences—Professor F C Waite, Western Reserve University, Cleveland
Psychology—Professor H A Aikins, Western Reserve University, Cleveland

Election of Members

The Membership Committee reported nine names for election to membership, sixteen additional names, previously approved by the Executive Committee and marked with (*) in the following list, were presented for ratification All were elected, as follows

*BANGHAM, RALPH V , Zoology, Anatomy, Dept of Zoology and Entomology, Ohio State University, Columbus
BEAM, J ALBERT, Zoology, 174 Greenfield St , Tiffin
*BOHSTEDT, G , Animal Nutrition and Genetics, Ohio Agricultural Experiment Station, Wooster
*BRYANT, WILLIAM L , Vertebrate Paleontology, American Anthropology, 1231 Elmwood Ave , Buffalo, N Y
CULP, VERNON L , Chemistry, Biology, Physiography, 837 Berwyn St , Akron
*DEAM CHARLES C , Botany, Forestry, Bluffton, Ind
*DEAN, FOREST W , Forestry, Botany, Entomology, Ohio Agricultural Experiment Station, Wooster
*FREER, RUSKIN S , Botany, East Liberty
*GILMOR, GRACE, Plant Physiology, Botany, R D No 1, Wooster
HARTZELL, ALBERT, Entomology, Zoology, Dept of Zoology and Entomology, Ohio State University, Columbus
*HITCHCOCK, FRED A , Zoology, Physiology, 1254 Wesley Ave , Columbus
*INMAN, ONDESS L , General Physiology, Antioch College, Yellow Springs
IRWIN, N MILDRED, Botany, 6405 Roe St , Cincinnati
*JOHNSON, HOWARD W , Botany, Dept of Botany, Ohio State University, Columbus
JONES, EDWARD S , Psychology, 79 S Cedar St , Oberlin
McEWEN, ROBERT STANLEY, Zoology, 208 Forest St , Oberlin
PAINTER, DONALD H , Geology, 318 Grand Ave , Dayton
*PHILLIPS, T G , Chemistry, Botany, Dept of Agricultural Chemistry, Ohio State University, Columbus
*SWINNERTON, ALLYN C , Geology, Antioch College, Yellow Springs,

VanHorn, Jesse Lower, Chemistry and Physics, 1490 Roycraft Ave , Lakewood
*Werner, William C , Botany, 422 N St Clair St , Painesville
*Whipple, Ralph W , Geology, Mineralogy, Paleontology, Anthropology, Marietta College, Marietta
*Willard, C J , Agronomy, Botany, Ohio State University, Columbus
Wilson, Herrick E , Geology, Zoology, Medicine, 224 W College St , Oberlin
*Young, W J , Botany, Ohio Agricultural Experiment Station, Wooster

Report of the Committee on Election of Fellows

The following report of the Committee on Election of Fellows was accepted and ordered filed

March 30, 1923

To the Ohio Academy of Science

A meeting of the Committee on Election of Fellows was held last evening in Oberlin Six members of the committee were present, three were represented by duly authorized proxies, two were absent without representation

Of the candidates considered eight received the necessary nine favorable votes and were declared elected The fellows elected will be personally notified, and the list will be published in the Proceedings

Respectfully submitted,
Edward L Rice, *Secretary,*
For the Committee

The list of members elected to fellowship is as follows

William Letchworth Bryant
Walter C Kraatz
Paul Marshall Rea
Septimus Sisson
Warren N Thayer
Roy Curtis Thomas
Lewis Hanford Tiffany
Edward L Wickliff

Resolutions

The following resolutions were adopted by the Academy

1 The Ohio Academy of Science hereby extends its cordial thanks to the Local Committee and the authorities of Oberlin College for the careful arrangements and many courtesies which have made possible this most successful meeting

2 The Academy desires also to thank Professor Henry C Cowles, of the University of Chicago, for the fascinating address on "Trees as Witnesses in Boundary Disputes' an Instance of Applied Ecology," and for his participation in the symposium on "Geographical Distribution of Plants and Animals"

3 The Academy further expresses to Professor Rice its gratitude for his years of service as secretary, a service involving much sacrifice on his part, and we record our appreciation of the fact that the increasing strength of the Academy during the last decade has been due in considerable measure to his influence

Report of the Committee on Necrology

The report of the Committee on Necrology consisted of a memoir of Emerson McMillin, 1844–1922, prepared and read by Dr T C Mendenhall The report was adopted by the Academy By action of the Executive Committee and Trustees of the Research Fund for 1923–24, to whom, as a joint committee, the matter was referred with power, this memoir has already appeared in the Ohio Journal of Science for May-June, 1923, and is omitted from the Annual Report

Amendments of Constitution

ART IV, SECTION 6*a* *Committee on State Parks and Conservation* New section, to be renumbered on reprinting of Constitution The Committee on State Parks and Conservation shall consist of nine members elected in accordance with the provisions of Section 16

ART IV, SECTION 15*a* *Duties of Committee on State Parks and Conservation* New section, to be renumbered on reprinting of Constitiuton The Committee on State Parks and Conservation shall consider the various possibilities in the formation of State Parks in areas of scenic, geologic, or biologic interest, and other effective methods for the preservation of the native fauna and flora and for the conservation of the natural resources of the State, it shall co-operate in all possible ways with other societies, institutions, and State officers in the promotion of these objects

ART IV, SECTION 16 *Terms of Office* Amended to read The President, Vice-Presidents, Secretary, Treasurer, and elective members of the Executive Committee and Publication Committee shall be elected annually at the annual meeting, and shall be eligible to re-election without limitation, with the exception of the President, who shall not be elected for successive terms The Trustees of the Research Fund, the members of the Library Committee, and the members of the Committee on State Parks and Conservation shall be elected for a term of three years, one Trustee, one member of the Library Committee, and three members of the Committee on State Parks and Conservation being elected each year

Amendment of By-Laws

CHAPTER II, SECTION 3 *Honorarium of Secretary* New section The Secretary shall receive an annual honorarium of one hundred dollars, from which he shall pay for any clerical help employed

McMillin Prize

A recommendation was presented by Dr T C Mendenhall, for the Trustees of the Research Fund, that the research fund of the Academy be invested as a permanent endowment, and that the interest derived from the same be devoted to a prize bearing the name of Mr Emerson McMillin

The general plan was endorsed by the Academy, and the working out of details was referred to the Executive Committee and the Trustees of the Research Fund for report at the next annual meeting For the year 1923–24 the use of the income of the research fund was referred to the Trustees with power

Uniform Spring Vacation

On the recommendation of the Executive Committee, it was voted that the Ohio Academy of Science heartily endorse the efforts of the Ohio College Association toward the securing of uniformity in the date of the spring vacation of the colleges of Ohio, as facilitating attendance at meetings of the Ohio College Association, Ohio Academy of Science, and other societies consisting largely of college men

Scientific Sessions

The complete scientific program of the meeting follows

PRESIDENTIAL ADDRESS

The aims of social evolution A P Weiss

PUBLIC LECTURE

Trees as witnesses in boundary disputes an instance of applied ecology, Henry C Cowles

SYMPOSIUM ON GEOGRAPHICAL DISTRIBUTION OF PLANTS AND ANIMALS

Geological factors in animal and plant distribution	G D Hubbard
Some factors in plant distribution	H C Cowles
The distribution of vegetation in relation to physiographic provinces,	E Lucy Braun
The places of origin of the several families of Anura	M M Metcalf
Factors which determine local distribution of spiders	W M Barrows
Some problems in the distribution of dragonflies (Lantern),	Clarence H Kennedy

SYMPOSIUM ON CURRENT PROBLEMS OF OHIO GEOLOGY

Early Paleozoic stratigraphy	W H Shideler
Middle Paleozoic stratigraphy	J Ernest Carman
Stratigraphy of the Carboniferous formations	J E Hyde
Paleozoic faunas and their correlation	A F Foerste
Some work yet to be done in Ohio physiography	Geo D Hubbard
Economic geology	J A Bownocker
Structural geology	W H Bucher

PAPERS

1	Weather and human conduct (30 min , lantern)	William H Alexander
2	Some Old World botanic gardens (25 min , lantern)	A E Waller
3	Some features of the Park Area of the Cleveland Metropolitan Park District (20 min , lantern)	E L Fullmer
4	The Cleveland Museum of Natural History (25 min)	P M Rea
5	An "eagle ' observatory at Vermilion, results obtained in 1922 (40 min , lantern)	Francis H Herrick
6	A contribution to our knowledge of the life history and physiology of Euglena (15 min)	W J Kostir
7	The so-called allelocatalytic effect in the reproduction of Protozoa (5 min)	W J Kostir
8	The persistence of archaic parasites through many geologic periods (10 min , opaque projection)	Maynard M Metcalf
9	The origin of American opalinids (15 min , opaque projection),	Maynard M Metcalf
10	Two new cestode parasites in black bass of Ohio, life history, distribution, etc (10 min)	Ralph V Bangham
11	Life history studies of Homoptera (10 min , lantern)	Herbert Osborn
12	Jumping mouse, Zapus hudsonius, in Ohio (10 min)	H A Gossard
13	The geographic distribution of Arctic Bryozoa (10 min , lantern),	Raymond C Osburn
14	The inheritance of the nail biting habit (10 min , lantern),	W M Barrows
15	A case of extra digits in the manus of the pig (10 min , lantern),	Stephen R Williams
16	On the origin of some embryonic abnormalities (10 min)	R A Budington

17 Comparative physiology as an undergraduate study (15 min), Chas G Rogers
18 Physiological evidences of animal relationship (15 min) Chas G Rogers
19 Lorain County Polyporaceae (5 min) F O Grover
20 The vegetation of Ohio (lantern) E N Transeau
21 Studies on the genus Ampelopsis (15 min , lantern) Grace Gilmor
22 Variations in the root system of the common everlasting Gnaphalium polycephalum (10 min) Helen Guhman
23 Soil reactions and plant succession (15 min), E Lucy Braun and Sylvia Geisler
24 Importance of resistance of the host in the control of plant diseases (20 min) W J Young
25 Observations on the sexual state of various plants (15 min), J H Schaffner
26 The time of sex determination in plants (12 min) J H Schaffner
27 Some chemical changes accompanying growth and reproduction in Spirogyra (15 min) L H Tiffany
28 Flora of the muck land of Delaware County, Indiana (10 min), Blanche McAvoy
29 Notes on the distribution of sea grasses (10 min , lantern), H H M Bowman
30 Prairie openings on the Little Miami River (20 min , lantern), M Mildred Irwin
31 Concerning some ostracoderms from Ohio (15 min , lantern), J Ernest Carman
32 The temperature and brightness of tungsten lamps (20 min), W E Forsythe
33 Effect of tension on change of resistance and thermoelectromotive force by transverse magnetization Alpheus W Smith

DEMONSTRATIONS

1 Methods of recording bird migration Lynds Jones
2 Drawings of penes of dragonflies Clarence H Kennedy
3 Preserved skin specimen of jumping mouse, Zapus hudsonius H A Gossard
4 A cent found in the pharynx of a cat from the comparative anatomy laboratory Stephen R Williams
5 Microscopic slides illustrating paper 13, on cestode parasites of black bass, Ralph V Bangham
6 Roots of the common everlasting Gnaphalium polycephalum variations described in paper 25 Helen Guhman
7 Thorns of honey locust Gleditsia triacanthos F E Bechtel
8 Twigs as a basis for winter tree study, a method of mounting, E Lucy Braun
9 Rainfall and vegetation map of Asia Geo D Hubbard
10 Drawings of opalinids Maynard M Metcalf
11 Distribution maps of opalinids and their hosts, illustrating papers 8 and 9 and contribution to symposium on geographical distribution, Maynard M Metcalf

THE TIME OF SEX DETERMINATION IN PLANTS *

JOHN H SCHAFFNER
Department of Botany, Ohio State University

Having devoted a considerable number of years to cytological investigations, especially on the nature and activity of the chromosomes, and having in the meantime acquired some knowledge of the taxonomy of plants in general and of the nature of their sexual manifestations, the writer at length became aware of the fact that the problems of sex determination, sex differentiation, and sex reversal lie entirely outside of the phenomena of chromosome aggregations and segregations which occur at the fertilization and reduction division periods Such a conclusion must be evident to anyone who compares a few plant life cycles in relation to these processes or makes a taxonomic study of a series of related plants with bisporangiate, monecious, or diecious flowers The mere fact that sex determination and segregation usually do not at all coincide with fertilization or reduction in the higher plants and also not in most lower forms, and that such coincidence is confined to a comparatively few out of many types of sexual cycles, made it plain that those botanists who were seeking an explanation of sex determination and sex segregation in a Mendelian formula of homozygous and heterozygous chromosome or factor constitutions were not only following a delusion, but attempting to establish an hypothesis of sexuality that would result in nothing except a contradiction of the most evident phenomena

A comparison of the various classes of plants from the lowest to the highest and a study of numerous life cycles indicate that practically all plants can be placed into three categories or evolutionary series in respect to their sexual states The lowest plants are apparent without sex and above these are two groups, each one definitely determined by a transition line, giving two definite evolutionary series The first transition is from the nonsexual plants to those with sexuality developed only in relation to the gametophyte If a sporophyte is present no sexual states are normally manifest, the universal condition being a homosporous sporophyte individual The second transition is from plants with sporophytes without sexual states to those with sporophytes showing sexual dimorphism at some stage of their development

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*Papers from the Department of Botany, The Ohio State University, No 142

In respect to sex, therefore, all plants can be classified into three general groups See Chart 1

I Plants entirely without sex

II Plants in which sexual states and sexual dimorphisms may arise in the gametes or gametophytes, but normally not in the sporophytes if such are present

III Plants in which sexual states and sexual dimorphisms arise in the sporophyte, the gametophytes also showing sexual dimorphism and normally always being unisexual

In both types of sexual plants, so far as they are multicellular, there are numerous independent series of forms ranging from hermaphrodites to unisexual individuals on the one hand and from individuals with bisporangiate sporophylls or flowers to diecious individuals on the other In both groups the beginning of the establishment of sexual states is near the end of the ontogeny, and in both evolution proceeds by the establishment of the sexual states at earlier and earlier periods in the ontogeny until finally the extreme cases are reached in the sexual state being determined on the one hand during the reduction division, and on the other in the fertilization period It is self evident, therefore, that some unisexual gametophytes have their sex determined at reduction and others at the beginning of the preceding generation, namely, at fertilization or at some other stage of the sporophyte Very commonly, and so far as we know perhaps all, unisexual gametophytes which have their sex determined at reduction may have their sexual state reversed to the opposite sex in either direction, and monosporangiate sporophytes which have their sex determined at fertilization may also have their sexual states reversed to the opposite sex in either direction

In all normal cases sex determination arises but once in the life cycle even though there is an alternation of generations in which it would be possible for the sex to be determined independently for both the gametophyte and sporophyte, were sex determination dependent on aggregation and segregation of chromosomes

We can compare the determination of maleness and femaleness with the ordinary process of morphological determination in the ontogeny In some plants and animals some change is brought about during the process of differentiation which interferes with regeneration so that no reproduction of the individual occurs In others renewed activity and reproduction of the entire individual are initiated through unusual stimuli

CHART I

THE THREE SERIES OR STAGES OF PLANTS IN RELATION TO THE SEXUAL STATE

Evolution of the sexual state in the sporophyte	VII ANGIOSPERMÆ VI GYMNOSPERMÆ V PTERIDOPHYTA HETEROSPORÆ	THIRD STAGE Sexual plants with an alternation of generations, the gametophyte being completely unisexual and the sporophyte always showing some sexual dimorphism, and on all levels except the lowest showing phyletic series ranging from individuals with bisporangiate flowers to monecious and finally diecious individuals Sexuality in the sporophyte attained independently in a number of groups
Evolution of the sexual state in the gametophyte	IV PTERIDOPHYTA HOMOSPORÆ III BRYOPHYTA II NEMATOPHYTA	SECOND STAGE Sexual plants with and without alternation of generations, only the gametes or gametophytes with sexual dimorphism, the sporophyte, when present, normally being in a neutral condition and homosporous, the gametophyte on all levels showing phyletic series from hermaphrodites to completely unisexual individuals Sexuality attained independently in a number of groups
Evolution of non sexual plants	I PROTOPHYTA	FIRST STAGE Plants without sex

In still others differentiation changes the physiological state of the cell so little that regeneration and somatic reproduction are very general phenomena Such reproduction often arises in cells highly differentiated morphologically, as when a protonema arises from a liverwort scale or from the diploid, sporophyte tissue of a moss

Apparently there are similar processes which determine the sexual states in the cell In some plants the sexual state is easily reversed, in other plants, both gametophytes and sporophytes, reversal is brought about with difficulty or not at all In the egg or spore then in which sexual states are established, as well as in hermaphrodites, plants with bisporangiate flowers, and monecious plants, sexual states may be strongly or weakly established

We do not need to be greatly concerned about the more or less equal numbers often maintained between the sexes, which seems to have been the main reason for the Mendelian hypotheses of sex If we assume that at a certain stage the cell is in a condition of balance or equilibrium so that a slight change of environment, either external or internal, will throw the sexual state in one direction or the other the sex ratio should remain nearly equal We necessarily are compelled to assume such physiological balances in any event when dealing with certain monecious types where, by a sex determination at a certain point and its reversal at a later stage, more or less constant numerical ratios result of the two types of flowers under a given environment, but which are entirely changed under a new environment If a constant ratio can be maintained between dimorphic branches on a common axis through changing physiological states, it is not such a very serious challenge when the dimorphism appears in a similarly constant ratio between independent units The writer has shown that in Arisaema triphyllum, for example, it would be possible to maintain almost any sex ratio desired by a simple environmental control It is also established that in Cannabis sativa the percentage of sex reversal follows closely the relative length of daylight, so that the actual percentage of reversal for any light period may be predicted about as accurately as the ordinary sex ratios of the higher animals or of the diecious plants

In those plants in which sexual states arise in the vegetative parts, which is the predominant type, the progression of internal environments, as cell lineage, senility, food supply, relation to more primary tissues, etc , usually are constant enough to put the plant through a regular cycle of sexual expression, just as is the case in the morphological expression, so that it is difficult to change the natural course of events If, however, we take a plant which has developed an hereditary constitution that unsettles the cell in respect to its sexual states, then the sequence of sexual expression is easily reversed and the part of the flower which should produce stamens may produce carpels or vice versa This is a common occurrence in such diecious plants as are just across the border line, evolutionally speaking, from the primitive and normal type of bisporangiate angiosperm flowers with the stamens develop first and the carpels above Familiar examples are various species of Thalictrum, in which in case of reversal stamens or carpels may arise in any position, although the lower bisporangiate Thalictrums have the stamens and carpels in the normal positions, i e , the stamens below and the carpels above

In a paper* published by the writer in 1918, entitled "The Expression of Sexual Dimorphism in Heterosporous Sporophytes," the statement was made that "The sexual state is thrown back, so to speak, into a small part of the sporophyte It is this spreading of the sexual state, with an ever increasing area of tissue involved, that constitutes one of the most interesting aspects of sporophyte evolution in the higher plants " The evolution of the gametophyte, of course, proceeds in the same way The difference between a plant with bisporangiate flowers and one with monecious or diecious flowers is a difference in hereditary constitution which induces a male or a female state to be established in the cells or to be reversed at an earlier or later stage of the ontogeny It is the setting up of a particular physiological condition which activates or controls the expression of hereditary factors into male or female characters that constitutes the real problem to be investigated, and not a search for segregating or associating hereditary factors or "sex chromosomes "

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*Ohio Jour Sci 18 101-125

The following diagram (Diagram 1) represents graphically the principal stages of the life cycle of the archegoniates and seed plants at which sex determination or sex reversal takes place in various species The successive stages show the actual evolutionary progression or phyletic series in relation to the sexual state It is important to note that whether the gametophyte be hermaphroditic or unisexual, whether the sporophyte be homosporous or heterosporous, there is normally

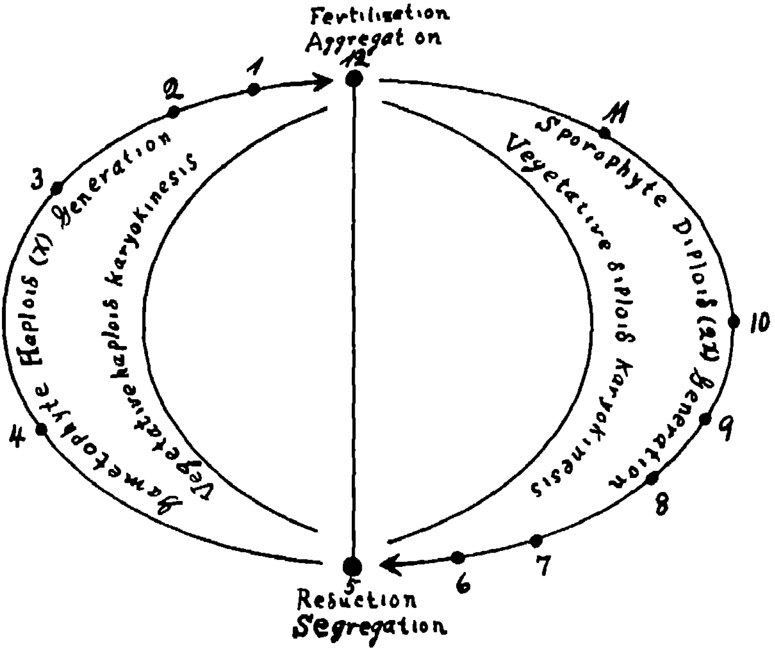
Fertilization
Aggregation
12
1
2
3
4
5
6
7
8
9
10
11
Haploid (X) Generation
Gametophyte
Vegetative haploid Karyokinesis
Sporophyte Diploid (2X) Generation
Vegetative diploid Karyokinesis
Reduction
Segregation

Diagram 1 Showing the various stages at which sex determination takes place in the life cycle in the main types of plants above the thallophytes

but one stage of sex determination in the life cycle which may, however, be followed soon after by a complete sex reversal If the sex is determined in the gametophyte there is none in the sporophyte, and if the sex is determined in the sporophyte it remains unchanged through the following gametophyte The numbers in the diagram represent the following conditions

1 The point at which sex is determined in plants with hermaphroditic gametophytes and homosporous sporophytes The sex is determined near the end of the ontogeny of the gametophyte—synoicous, hermaphroditic gametophytes The

antheridia and archegonia are commingled and sexual dimorphism can appear only in these structures, i e, between stages 1 and 12

2 The point at which sex is determined in plants with homosporous sporophytes and paroicous, hermaphroditic gametophytes In this case sexual dimorphism may be present beyond the gametangia and the opposite sex is expressed farther up on the elongating axis Sexual dimorphism can appear only between stages 2 and 12

3 The point at which sex determination takes place in plants with homosporous sporophytes and autoicous, hermaphroditic gametophytes Entire branches or tips of branches are determined with one sex or the other Sexual dimorphism is possible between stages 3 and 12

4 The point at which sex is determined in plants with homosporous sporophytes and with the extreme type of autoicous, hermaphroditic gametophytes in which large branches or branching systems have but one kind of sex organs In various liverworts and mosses such branches often become separated, giving rise to apparently unisexual gametophytes Sexual dimorphism may appear between 4 and 12

5 Time of the reduction division or segregation of chromosomes If sex determination takes place at this point the gametophytes become unisexual, with possible sex reversal later in the ontogeny of the gametophyte The sporophyte remains homosporous Sexual dimorphism is possible in the entire gametophyte, from 5 to 12

6 The point at which the sexual state is first determined in the sporophyte—heterosporous plants with unisexual gametophytes Sex determination takes place in the incipient megasporangia and microsporangia or in separate sori on the same leaf or in the floral axis, giving rise to dimorphic sporophylls in the same flower (bisporangiate flowers) Sexual dimorphism present between 6 to 5 to 12

7 The point at which sex determination takes place in monecious plants with commingled staminate and carpellate flowers, the sex being established at the base of the floral axis Sexual dimorphism present from 7 to 5 to 12

8 The time at which sex determination first takes place and is later reversed in monecious plants having inflorescences

with maleness determined below and femaleness above or vice versa Sexual dimorphism from 8 to 5 to 12

9 The point at which sex determination takes place, in monecious plants, at the base of the inflorescence, normally without reversal Sexual dimorphism possible from 9 to 5 to 12

10 The point at which sex determination takes place in monecious plants having the sporophyte developed with large monosporangiate branches Sexual dimorphism present to a greater or less degree from 10 to 5 to 12

11 The point at which sex determination takes place in monecious plants with the main parts of the body differentiated into staminate and carpellate systems Sexual dimorphism present to a greater or less degree from 11 to 5 to 12

12 Time of fertilization, or aggregation of chromosomes The time of sex determination in diecious plants The sporophytes are entirely monosporangiate under normal conditions, either staminate or carpellate The determination of the sexual state of the sporophyte and following gametophyte takes place in the egg before fertilization, during the fertilization period or in the early stages of the zygote Sexual dimorphism is possible in the entire sporophyte individual as well as in the entire gametophyte, i e , in the entire life cycle from 12 to 5 to 12

There are, of course, all possible types of intergradation between these main stages In most cases plants may have determination of sex at an earlier or later stage of development than the normal one In some species, like Zea mays, there may be much variation, both through the operation of environmental factors and because of differences in hereditary constitution There is also a possibility of sex reversal in most of the types, except apparently in the gametophytes of heterosporous plants and in a few lower unisexual gametophytes Specific abnormalities also occur here and there, as for example, cases of apospory and apogamy

By referring to the diagram it will be seen that at two points in the life cycle the time of sex determination coincides with chromosome shiftings, i e , in those plants with monosporangiate, heterosporous sporophytes and unisexual gametophytes and in those plants with unisexual gametophytes and homosporous sporophytes In the former it is possible to apply a homozygous-heterozygous allosome or sex factor formula, in the latter, a haploid allosome or sex factor formula The writer has shown by experiments on Cannabis, Humulus, Acnida, Thalictrum, and Arisaema that the homozygous-heterozygous hypothesis is not true, and Mrs Dorothy Elizabeth Wuist Brown's* experiments with the Ostrich fern show that a segregation, or haploid sex formula, does not hold for unisexual gametophytes having homosporous sporophytes, since she was able to induce sex reversal in both the male and female thalli The same conditions have been found for the unisexual gametophytes of Equisetum arvense A glance at the diagram will show that no haploid, segregation allosome, or sex factor can hold for the unisexual gametophytes of heterosporous plants, since the sex is determined before reduction and both cells of the reduction division continue to have the same sex in the gametophyte

But even if no conclusive experimental evidence were present to show that the hypothesis of Mendelian sex determination is a delusion, would it not be the mark of rashness to assume that the sex determination which takes place at the fertilization and reduction stages must be of a fundamentally different nature, with a new chemistry, physics, or physiology, than the exactly similar sex determination which takes place at the various other stages of the gametophyte and sporophyte ontogenies?

The writer does not at present wish to enter into a discussion of the problem as it affects the higher animals with an allosome difference, except to state positively that the elaborate scheme of sex formulae and nomenclature set up in the past few years has apparently no more foundation on which to rest in the animal kingdom than in the plant kingdom The whole matter can be consistently explained in an entirely different way Again, it is necessary to insist on some convincing evidence before the sexuality of plants and of the hermaphroditic animals is divorced from that of the higher unisexual animals

In the case of an allosome difference it may be true that the difference in heredity between the two bodies may profoundly influence the functional activity of the cell and thus bring about one sexual state or the other, but if this is the case it is in the end only a mode of functional activity of the same nature as when sexual states are determined or reversed in organisms without an allosome difference

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*Wuist, Elizabeth Dorothy Sex and Development of the Gametophytes of Onoclea struthiopteris, Physiol Res 1.93-132 1913

As stated above, in both the gametophyte generation of homosporous plants, including bryophytes and homosporous pteridophytes, and in the sporophyte generation of the heterosporous plants, including heterosporous pteridophytes, gymnosperms, and angiosperms, there are numerous repetitions of the evolutionary sequence of sexual states with various intergradations in each series Thus it is in the gametophyte of the homosporous plants that sexuality is to be studied, since the sporophyte is normally neutral, while in the heterosporous plants, the gametophyte being unisexual, it is the sporophyte that shows the evolutionary progression of the determination of sexual states In the first, the progression is repeated on practically all levels, the series running from hermaphrodites, often with closely associated organs of the two sexes through various gradations as synoicous, paroicous, and autoicous, to distinctly unisexual individuals It must be remembered that all these gradations arise in the presence of the haploid number of chromosomes In the second, i e, the hetersoporous sporophyte type, the gradation proceeds from the lowest stage with closely associated microsporangia and megasporangia in the same sorus, to differentiated sori, and then to the more typical bisporangiate flower with distinct microsporophylls and megasporophylls, and from this stage on through the various types of monecious plants to the typical diecious species These gradations, duplicating those of the gametophyte, appear in the presence of the diploid number of chromosomes

Below is given a characteristic list of plants, extending from the lower liverworts to the highest dicotyls This representative list will clearly indicate the relation that exists between the different types of sexual expressions and their independence of aggregating and segregating, Mendelian hereditary units Such examples could be extended indefinitely, but a study of these given should be sufficient to lead anyone to a comprehension of the real nature of sexuality and the nature of the problems to be solved Seen in their proper light, they should also be able to clear the minds of any who may have become confused or befogged by the acceptance of the homozygous-heterozygous formula as an explanation of sexuality as it is actually developed in organisms

Series of species of gametophytes of the homosporous higher plants and of sporophytes of the heterosporous plants to show the nature of the relation of the unisexual state of the individual to the bisexual state

BRYOPHYTA

I Riccia group —*Riccia crystallina* L , hermaphrodite, *R michelii* Raddi, unisexual, *Ricciocarpus natans* (L) Corda, hermaphrodite or apparently sometimes unisexual

II Marchantia group —*Targionia hypophylla* L , hermaphrodite, *Reboulia hemisphærica* (L) Radi, individuals either hermaphrodite or unisexual, *Marchantia polymorpha* L , unisexual but occasionally hermaphroditic individuals have appeared, *Conocephalum conicum* (L) Dum , unisexual

III *Sphaerocarpus terrestris* (Micheli) Sm , unisexual with an allosome difference

IV Metzgeria group —*Metzgeria conjugata* Lindb , hermaphrodite, *M pubescens* (Schrank) Raddi, unisexual

V Fosombronia group —*Fosombronia foveolata* Lind , hermaphrodite (either synoicous or paroicous), *F wondraczeki* (Corda) Dum , hermaphrodite (paroicous), *F caespitiformis* De Not , hermaphrodite (paroicous) and unisexual, *F angulosa* (Dicks) Raddi, unisexual

VI Cephalozia group —*Cephalozia bicuspidata* (L) Dum , hermaphrodite (autoicous), *C lammersiana* (Hueb) Spruce, hermaphrodite (autoicous) or apparently unisexual by the separation of male and female branches, *C serriflora* Lind unisexual

VII Cephaloziella group —*Cephaloziella elegans* (Heeg) K M , hermaphrodite (paroicous), *C striatula* (Jens) Douin, hermaphrodite (autoicous but occasionally paroicous), *C hampeana* (Nees) Schiffn , hermaphrodite (autoicous), *C myriantha* (Lind) Schiffn , hermaphrodite (paroicous) and occasionally pure male and female individuals produced, *C starkei* (Funck) Schiffn , unisexual

VIII Frullania group —*Frullania saxicola* Aust , hermaphrodite (autoicous), *F tamarisci* (L) Dum , this and most species of the genus unisexual

IX Bog-moss group —*Sphagnum rigidum* Schp , hermaphrodite, *S squarrosum* (Pers) Schwaeg , either hermaphrodite or unisexual, *S cymbifolium* Ehrh , unisexual

X Granite Moss group —*Andreaea petrophila* Ehrh , hermaphrodite (autoicous), *A nivalis* Hook , unisexual

XI Grimmia group —*Grimmia apocarpa* (L) Hedw , hermaphrodite (autoicous), *G alpestris* Schleich , unisexual or rarely hermaphroditic (autoicous), *G trichophylla* Grev , unisexual

XII Bryum group —*Bryum arcticum* R Br , hermaphrodite (synoicous), *B provinciale* Philib , hermaphrodite, often synoicous and autoicous branches on the same plant, *B warneum* Bland, hermaphrodite (autoicous, rarely synoicous), *B marratii* Wils, hermaphrodite (autoicus), *B roseum* Schreb, unisexual

XIII Hypnum group —*Hypnum polygamum* Schp, hermaphrodite (synoicous or autoicous), *H riparium* L hermaphrodite (autoicous), *H exannulatum* Guemb, unisexual, rarely hermaphroditic (autoicous), *H aduncum* Hedw, unisexual

XIV Splachnum group —*Splachnum ampullaceum* L, hermaphrodite (autoicous), *S vasculosum* L, unisexual

XV Hair-cap Moss group —*Catharinaea undulata* Web & Mohr, hermaphrodite (synoicous and paroicous), *C tenella* Roehl, unisexual, *Polytrichum commune* L, unisexual The tendency in the higher mosses is to be unisexual

PTERIDOPHYTA HOMOSPORÆ

XVI Eusporangiate ferns —*Botrychium virginianum* (L) Sw, hermaphrodite, *Marattia douglasii* (Presl) Baker, usually hermaphroditic but sometimes thalli appear with only antheridia present

XVII Leptosporangiate ferns —*Adiantum capillus-veneris* L, hermaphrodite, antheridia develop first and later toward the anterior end an area of archegonia is developed, *Pteretis nodulosa* (Mx) Nieuwl, American Ostrich-fern (*Onoclea struthiopteris* L of authors), typically unisexual According to the investigations of Mrs Elizabeth Dorothy Wuist Brown, about 15% of the thalli in old cultures in soil were hermaphroditic She was able to induce 90% of the female thalli later to produce antheridia Only 5% of the male thalli were induced later to produce archegonia

XVIII Equisetum —*Equisetum laevigatum* A Br, thalli hermaphroditic, *E arvense* L, thalli unisexual with sex reversal in both directions, but more commonly the females changing to the male condition Note So far as known, in both the leptosporangiate ferns and in the horsetails, the unisexual thalli occur in the species with the most highly evolved sporophytes

XIX Lycopods —*Lycopodium complanatum* L, has hermaphroditic gametophytes

HETEROSPOROUS SPOROPHYTE SERIES, THE GAMETOPHYTES BEING UNISEXUAL

XX Heterosporous Pteridophytes —*Marsilea quadrifolia* L, microsporangia and megasporangia in the same sorus, *Salvinia natans* (L) Hoff, microsporangia and megasporangia in distinct sori on the same leaf, *Selaginella rupestris* (L) Spring, microsporangia and megasporangia on distinct sporophylls, but on the same floral axis, i e, flowers bisporangiate

ANGIOSPERMÆ

XXI The Lowest Helobiæ —*Echinodorus cordifolius* (L) Griseb, flowers bisporangiate, *Lophotocarpus calycinus* (Engelm) Sm, bisporangiate in lower part of inflorescence, staminate with vestigial carpels in the upper part, *Sagittaria longirostris* (Micheli) Sm, monecious, with carpellate flowers below and staminate above or sometimes the entire inflorescence staminate or carpellate, doubtful whether there are really diecious individuals, *Burnatia enneandra* (Hochst) Micheli, diecious

XXII Palms —*Sabal palmetto* (Walt) R & S, flowers bisporangiate, *Cocos nucifera* L, monecious, the staminate and carpellate flowers on the same inflorescence with occasional intermediate flowers on the transition tissue, *Phoenix dactylifera* L, diecious, but occasionally with sex reversal at least on the staminate plant Note Palms of all gradations of sexual expression occur between the bisporangiate and diecious types

XXIII Aroids —*Acorus calamus* L, flowers bisporangiate, *Peltandra virginica* (L) Kunth, monecious, with a transition zone between the carpellate flowers below and the staminate above, *Ariseama dracontium* (L) Schott, monecious and staminate individuals, the staminate usually greatly predominating, monecious individuals ranging from those having only a few carpellate flowers below to those with only a few staminate flowers above, sex reversal of both types general, the staminate to monecious, and the monecious to staminate, *Arisaema triphyllum* (L) Torr, diecious, with a considerable percentage of monecious individuals ranging from almost completely staminate, to almost completely carpellate sex reversal in all types of individuals general in all directions

XXIV Sedges —*Scirpus validus* Vahl, flowers bisporangiate, *Cymophyllus fraseri* (Andr) Mackenz, monecious, the spikelet carpellate below and staminate above, *Carex gracillima* Schwein, monecious, spikelets staminate below, carpellate above, *C lupulina* Muhl, monecious, the entire spikelets are either carpellate or staminate, *C exilis* Dewey, sometimes diecious, sometimes with staminate flowers above and carpellate flowers below, and sometimes with carpellate flowers above and staminate below, *C dioica* L, diecious

XXV Grasses —*Festuca elatior* L, flowers bisporangiate, *Panicum virgatum* L Spikelets with a bisporangiate and a staminate flower, *Andropogon furcatus* Muhl, with paired spikelets, one with a bisporangiate flower, the other with a staminate flower, *Zizaniopsis miliacea* (Mx) D & A, monecious, the panicle with carpellate spikelets and staminate spikelets, the carpellate borne at the base of the branches and the staminate at the ends, *Zizania aquatica* L, monecious, staminate spikelets in the lower part of the panicle, and carpellate spikelets at the upper end, with spikelets containing bisporangiate flowers on the transition zone, *Tripsacum dactyloides* L, monecious, the lower part of the inflorescence with carpellate spikelets and the upper with staminate spikelets, *Zea mays* L, monecious, normally with completely distinct staminate and carpellate inflorescences, but often with many intermediate developments, *Scleropogon karwinskyanus* (Fourn) Benth, diecious, *Bulbilis dactyloides* (Nutt) Raf, diecious but apparently monecious individuals have been reported

XXVI Bunch-flower sub-family —*Anticlea elegans* (Pursh) Rydb , flowers bisporangiate, *Zygadenus glaberrimus* Mx , flowers mostly bisporangiate, *Stenanthium robustum* Wats , inflorescence with bisporangiate and monosporangiate flowers, *Melanthium latifolium* Desr , monecious, both sorts of flowers scattered in the same inflorescence, probably with some intermediate flowers, *Chamaelirium luteum* (L) Gr , diecious

XXVII Thalictrum group —*Thalictrum clavatum* DC , flowers bisporangiate, *T dasycarpum* Fisch & Lall , flowers bisporangiate or monosporangiate, plants monecious to diecious with change of sexual expression in the individual from time to time, *T revolutum* DC , diecious or some plants with both stamens and carpels, *T dioicum* L , diecious, with occasional individuals of various grades of intermediateness

XXVIII Clematis group of genera —*Atragene americana* Sims, flowers bisporangiate, *Clematis virginiana* L , diecious with some intermediate flowers occasionally present

XXIX Spurge group —*Geranium maculatum* L , flowers bisporangiate, *Callitriche austeni* Engelm , with bisporangiate and monosporangiate flowers, *Croton monanthogynus* Mx , monecious with commingled flowers, *Ricinus communis* L , monecious with staminate flowers on the lower part of the panicle and carpellate flowers above, occasionally with bisporangiate flowers on the transition zone, *Stillingia sylvatica* L , monecious, with carpellate flowers below and staminate above, *Chamaesyce maculata* (L) Small, monecious, with reduced carpellate and staminate flowers close together in a cyathium, *Mercurialis annua* L , diecious with some intermediate individuals, *Croton texensis* (Klotzsch) Muell , diecious, with considerable vegetative sexual dimorphism

XXX Amaranth group —*Froelichia campestris* Small, flowers bisporangiate, *Amaranthus spinosus* L , monecious, *Amaranthus palmeri* Wats , diecious, with intermediates, *Acnida tamariscina* (Nutt) Wood, diecious, with occasional sex reversal in both staminate and carpellate plants

XXXI Rumex group —*Oxyria digyna* (L) Hill, flowers bisporangiate, *Rumex crispus* L , with bisporangiate and carpellate flowers on the same plant, *Rumex altissimus* Wood , monecious with vestiges in both the staminate and carpellate flowers, *Rumex acetosella* L , diecious

XXXII Rose family —*Duchesnea indica* (Andr) Focke, flowers bisporangiate, *Poterium sanguisorba* L , with bisporangiate and monosporangiate flowers in the heads, *Fragaria vesca* L , diecious, with monecious individuals, *Aruncus aruncus* (L) Karst , diecious

XXXIII Bean family —*Hoffmanseggia jamesii* T & G , flowers bisporangiate, *Gleditsia triacanthos* L , with bisporangiate and monosporangiate flowers, *Gymnocladus dioica* (L) Koch, diecious, both flowers with prominent vestiges

XXXIV Maple group —*Staphylea trifolia* L , flowers bisporangiate, *Aesculus glabra* Willd , monecious, both flowers in the same cluster, *Acer platanoides* L, diecious, with frequent reversals of flowers or branches to the opposite sex, *A saccharinum* L, diecious, with sex reversal in both directions, *A negundo* L, diecious

XXXV Nettle group —*Ulmus americana* L, flowers bisporangiate, *Parietaria pennsylvanica* Muhl, with bisporangiate and monosporangiate flowers, *Humulus japonicus* Sieb & Zucc, diecious, with sex reversal in either direction, *Cannabis sativa* L, diecious, with no vestiges in the flowers but with distinct vegetative dimorphism, some races with monecious individuals, mostly with abundant sex reversal in either direction under proper environment, especially under short light periods alternating with long periods of darkness

XXXVI Woody amentifers —*Alnus incana* (L) Willd, monecious, *Myrica gale* L, diecious, with sex intermediates and with sex reversal in either direction, *Salix amygdaloides* Anders, diecious with occasional monecious individuals, *Populus deltoides* Marsh, diecious

XXXVII Evening primrose type —*Oenothera biennis* L, flowers bisporangiate, *Proserpinaca palustris* L, flowers bisporangiate, *Myriophyllum heterophyllum* Mx, monecious, with carpellate flowers below and staminate above on the inflorescence and with bisporangiate flowers on the transition zone, *Myriophyllum proserpinacoides* Gill, is said to be nearly diecious, *Fuchsia procumbens* Cunn, diecious

XXXVIII Cucurbit group —*Asarum canadense* L, flowers bisporangiate, *Cucumis melo* L, monecious, but often with some functional bisporangiate flowers, *Cucurbita foetidissima* H B K, monecious, *Sicyos angulatus* L, monecious, staminate and carpellate inflorescence arising from the same node, *Bryonia alba* L, monecious, *Bryonia dioica* L, diecious

XXXIX Ebony group —*Bumelia lycioides* (L) Pers, flowers bisporangiate, *Symplocos tinctoria* (L) L'Her, with bisporangiate and staminate flowers, *Diospyros virginiana* L, diecious

XL Fraxinus group —*Syringa vulgaris* L, flowers bisporangiate, *Fraxinus ornus* L, flowers bisporangiate or imperfectly bisporangiate, *F quadrangulata* Mx, flowers bisporangiate or imperfectly bisporangiate, *F americana* L, diecious

XLI Plantain group —*Plantago rugelii* Decne, flowers bisporangiate, *Littorella uniflora* (L) Asch, monecious, with decided dimorphism of the peduncle, *Plantago heterophylla* Nutt, diecious, with some bisporangiate flowers, *P virginica* L, diecious

XLII Valeriana —*Valeriana pubicarpa* Rydb, flowers bisporangiate, *V edulis* Nutt, imperfectly diecious, with bisporangiate and monosporangiate flowers, *V acutiloba* Rydb, diecious and dimorphic

XLIII Ragweed group —*Iva ciliata* Willd, monecious, marginal flowers of the heads carpellate, central flowers staminate, *Ambrosia trifida* L, monecious, carpellate heads below, staminate heads above

XLIV Composits —*Lacinaria scariosa* (L) Hill, flowers bisporangiate, *Inula helenium* L, outer, ray flowers carpellate, inner, disk flowers bisporangiate, *Silphium perfoliatum* L, monecious, outer flowers carpellate and inner staminate, *Baccharis salicina* T & G, diecious, *Antennaria plantaginifolia* (L) Rich, diecious, with dimorphic inflorescence

XLV Genus Artemisia.—*Artemisia tridentata* Nutt, all the flowers bisporangiate, *A absinthium* L, marginal flowers carpellate, central flowers bisporangiate, *A caudata* Mx, marginal flowers carpellate, central flowers staminate

XLVI Genus Cirsium—*Cirsium undulatum* (Nutt) Spreng, flowers bisporangiate, *C arvense* (L) Scop, diecious or imperfectly diecious

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SCIENTIFIC RESULTS OF THE KATMAI EXPEDITION OF THE NATIONAL GEOGRAPHIC SOCIETY

DIPTERA OF THE FAMILY DOLICHOPODIDAE

M C VAN DUZEE

Campsicnemus clandicans, Loew

Nine males and thirty-six females were taken at Kodiak, June, 1917, and Savonoski, Naknek Lake, in July, 1919 This species was described from Alaska, Dr Aldrich has reported it from Idaho

Campsicnemus degener, Wheeler

Four males were taken at Savonoski, Naknek Lake, Alaska, in July, 1919 This species has been taken only in California and Idaho as far as known to me, it is interesting to find it in Alaska

Porphyrops consobrina, Zett

Fifteen males and ten females taken in Alaska in June and July, 1917, and 1919, at Katmai, and Savonoski, Naknek Lake

Coquillett reported this species from Alaska in 1900, Dr Aldrich in his Catalogue of Diptera, 1905, in a note says the determination of this species seem to be premature, but I have compared these Alaska specimens with Dr Lundbeck's description of that species and cannot see where there can be any doubt of its identity Am giving below the characters that distinguish the species

Face narrow, silvery white Palpi black Beard yellowish white Third antennal joint nearly twice as long as the two basal joints taken together, arista shorter or about as long as the antenna Hypopygium with its outer lamellæ (Fig 1 a) short blackish, the apical part somewhat triangular, about as long as wide, and about as long as the stem, which is rather broad, inner appendages (Fig 1 b) black, lanceolate, nearly as long as the outer lamella All coxæ black with long pale hair, middle pair without a spine at tip All femora black with yellow tips, posterior pair with one or two preapical bristles, middle pair with long white hair below at base and a few black bristles on each side at tip, fore femora thickest in the middle, with long black bristles below for their entire length, these are as long as the width of the femora, on the posterior surface there are long pale hairs, but the upper row of long hairs is black Hind tibiæ black with the upper edge yellow almost to the tip, or yellowish with the tip broadly black, its bristles short Fore and middle tibiæ pale yellow with strong bristles Fore tarsi (Fig 1) as long as their tibiæ, the first joint fully as long as second, slightly widened below and with a row of stiff black hairs above and below, second joint very slightly enlarged at base, or I might say slightly narrowed just beyond the base below, last three joints taken together but little longer than the first, fifth nearly as long as the third and fourth together Hind basitars about (sometimes scarcely) as long as second joint

Wings grayish hyaline, third vein with a gentle and even curve, last section of fourth vein a little bent at its middle, nearly parallel with the third at tip and ending in the apex of the wing, last section of fifth vein a little longer than the cross-vein, hind margin of wing nearly evenly rounded, still a little expanded basilly from the tip of fifth vein

Porphyrops elegantula, Meig

Four males and seven females were taken at Savonoski, Naknek Lake, Alaska, in July, 1919

The male of this large fine Europian species is easily distinguished by its bright metallic color, the sixth abdominal segment being steel blue or violet The outer lamellæ of the hypopygium (Fig 2) are long, simple narrow, pointed and of a yellowish or light brown color Inner appendages black and slightly spoon-shaped, as long as the width of the hypopygium Both the middle and hind coxæ have black spines at their tip, those on hind coxæ the shortest Femora yellow, the posterior pair with black tips and two preapical bristles Fore basitarsi expanded at tip below, as long as the two following joints taken together Arista as long or a little longer than the antenna Face silvery white, narrow, palpi grayish or yellow, third vein gently arched, last section of fourth vein nearly straight

Porphyrops crassipes, Meig

Two males and two females were taken at Savonoski, Naknek Lake, Alaska, in July, 1919

There can be no doubt of this determination, it is an interesting species the distinguishing characters of which are

Face narrow, silvery white Beard white, abundant Arista longer than the antennæ Hypopygium with the outer lamellæ yellowish, very long and slender, forked near the middle, one branch shorter than the other Fore and hind femora black, the latter considerably thickened, with a preapical bristle Fore coxæ blackish with long white hair, posterior pair with a tuft of black bristles at tip (not forming a spine), middle pair without a spine at tip Middle femora mostly yellow, blackened at base only, their tibiæ and tarsi yellow, last two joints of the tarsi (Fig 3) black, compressed and widened, forming together an oval tip to the tarsi, which is not much longer than wide, the fourth joint shorter than the fifth Fore femora with long white hair on the posterior surface, fore tarsus as in Fig 3 a, middle ones with some white hairs at base below Wings rather broad widest between the tips of fifth and sixth veins, the hind margin sinuous, last section of fourth vein and the third vein much bent so that they are much further apart near the middle of last section of fourth than at their tips

Porphyrops tricaudata, new species

Male Length, 4 mm, of wing the same Face very narrow, silvery white Palpi black Front green Antennæ black, third joint about twice as long as the two basal joints taken together Arista about as long as the antenna Orbital cilia black, descending to upper third of the eye Beard abundant, whitish, eyes with white hair

Thorax and abdomen green, a little dulled with grayish pollen the former with the usual two dark lines in front Hypopygium (Fig 4) black with its outer lamellæ divided into three long branches, the posterior one the shortest, they are brownish, fringed with long pale hairs, inner appendages black, straight, styliform

Coxæ and femora black, fore and middle femora yellow at tip Fore coxæ with long white hair on its anterior surface, without black ones at tip Middle and hind coxæ with less abundant white hair, without a spine at tip Fore femora with rather long pale hair on posterior surface, those near the tip black and bristle-like Middle femora with long white hairs below on basal half and several black bristles on each side at tip Hind femora with one or two preapical bristles Tibiæ yellow, fore and middle ones each with two rows of long bristles, posterior pair a little blackened at tip, its bristles rather strong, but shorter than on the other tibiæ Fore tarsi (Fig 4 a) longer than their tibiæ, the first two joints and base of third yellow, last three joints black, first joint thickened at tip, as long as second, second a little excavated below near the base and slightly so before the tip, first and basal half of second joint with a row of minute blunt spines below, third and fifth joints of nearly equal length, fourth a little shorter, middle tarsi yellow with last two joints black, of nearly equal length, slightly compressed, so that the fifth is twice as wide as the third Hind tarsi brown, only the last two joints black, first scarcely longer than the second and about equal to the third and fourth taken together, fifth joint but little longer than wide Calypters, their cilia and the halteres yellow

Wings grayish, third vein gently and evenly arched, last section of fourth vein a little bent just beyond its middle, nearly parallel with third towards its tip, ending in the apex of the wing, last section of fifth vein scarcely twice as long as the cross-vein, hind margin of wing nearly evenly rounded

Female Face wide, gray, the ground color sometimes showing through on the lower part, which is somewhat rounded in outline below, suture just below the middle of the face Antennæ black, small, third joint about as long as wide, scarcely pointed at tip, arista nearly three times as long as the antenna Front opaque with gray pollen. Beard yellowish white Palpi large, obtusely pointed, black with black hair and white pollen Fore coxæ more or less yellowish with rather long white hair, I see two black hairs at tip in some specimens Femora and tibiæ yellow, posterior femora and tibiæ blackened at tips Fore femora with a row of rather long black hairs on upper posterior edge, ending in several slender bristles Middle and hind femora each with one or more preapical bristles Fore and middle tarsi darkened from the tip of first joint, still only the apical joints black, both with their joints normal, the first joint being nearly as long as the following three joints taken together Hind tarsi about as in the male Wings as in the male, except that the last section of fifth vein is fully twice as long as the cross-vein

Described from one male and seven females, taken at Savonoski, Naknek, Lake Alaska, in June and July, 1919, and two females from Katmai, Alaska, in August, 1917

This is very much like *tridactyla* Frey, from Lapland The male differs in having the inner appendages of the hypopygium nearly straight and not enlarged at tip, and in having the hind tibiæ largely yellow

The outer lamellæ are also very slightly different from his drawing of those of *tridactyla* The female differs in having the tips of the hind femora broadly black on upper and lateral surfaces The front nearly opaque with white pollen, and the last two joints of middle tarsi not widened

Porphyrops sp

One female from Katmai, Alaska, July, 1917

Has the face with brownish pollen, antennæ short, third joint as wide as long, the arista about three times as long as the antennæ, beard long, yellowish Fore coxæ with very long yellow hair, no black ones at tip, fore femora black at base with whitish hairs below on basal half and long black ones on apical two-thirds of posterior surface, fore tarsi longer than their tibiæ, black from the tip of the first joint, the first joint scarcely as long as the two following joints together, third and fourth veins of the wing gently bent, last section of fifth vein fully twice as long as the cross-vein

Porphyrops sp

Four females from Savonoski, Naknek Lake, Alaska, taken in June and July, 1919

Face with the suture near the middle, its pollen yellowish, lower part somewhat metallic Antennæ short, arista about three times as long as the antenna Hair on fore coxæ moderate long, yellowish white, no black ones at tip, fore femora yellow with a row of black hairs on upper posterior edge, ending on two bristles, fore tarsi longer than their tibiæ, blackened from the tip of the first joint, which is as long as the two following taken together, middle femora with several, hind ones with one preapical bristle Third vein nearly straight, last section of fourth vein a little bent at its middle, last section of fifth vein nearly twice as long as the cross-vein

Porphyrops nigra, new species

Male Length, 4 mm , of wing, 3 7 mm Face very narrow, black Palpi black Front opaque black, eyes with brown hairs Antennæ black, third joint about as long as the two basal joints taken together, arista about equal to the antenna in length Hairs of the beard mixed black and brownish

Thorax black, scarcely at all greenish on the dorsum, which is dulled with brown pollen Abdomen dark green, the apical segments almost black Hypopygium black, its outer lamellæ very broad at base (Fig 5 a), forked, one branch wide, short and blunt, the other long, rather narrow and more pointed, they are brownish, inner appendages (Fig 5 b) yellow, black at upper corner, enlarged and truncate at tip, fringed with pale hairs Coxæ black with long black hairs, middle pair with a long black thorn at tip Femora black, a little yellowish at tip fore femora with long black hair on posterior surface, middle femora with long black hair below and three slender bristles on posterior side and one on anterior side at tip, hind femora with long black hair below, which is a little longer towards their tips Fore tibiæ more than half black, middle pair yellowish, blackened on basal half above, four anterior tibiæ with strong bristles, hind tibiæ dark yellow, scarcely darker at tip, but dark at base, thickened towards the tip their bristles stout Fore tarsi (Fig 5) one and a fourth times as long as their tibia, black from the tip of the first joint, still the base of the second joint a very little yellow, first joint as long as second, a very little thickened at tip, second joint abruptly narrowed near the base, both these joints with minute blunt black spines below, the three apical joints of nearly equal length Middle tarsi with the two first joints yellow, the second half as long as the first (other joints missing) Hind tarsi black, second joint shorter than the first and fifth, only slightly shorter than the fourth Calypters and halteres yellow, the former with black cilia

Wings dark gray, with black veins, third vein considerably but evenly arched, last section of fourth vein only slightly bent near apical third, ending slightly back of the apex of the wing, last section of fifth vein about twice as long as the cross-vein, hind margin of wing nearly evenly rounded

Female A female that I think belongs with the male described above, although not taken at the same place or in the same year, has the wing about as in the male, except that they are a little darker with a slightly hyaline spot around the cross-vein, the bend in the last section of the fourth vein is a little nearer its center, but otherwise about the same, it ends just back of the apex of the wing as in the male The face is gray with the suture near its center, palpi black with black hairs, beard whitish, front, thorax and abdomen green with gray pollen, coxæ with long white hairs Femora black with yellowish tips, fore femora with long white hair on the posterior surface, middle and hind ones with pale hairs below, the latter with a row of slender black bristles on lower outer edge, middle femora with two bristles on each side at tip, fore and middle tibiæ yellow, hind ones like those of the male, fore and middle tarsi as long as their tibiæ, darkened from the tip of the first joint, which is as long as the three following taken together

Described from one male taken at Katmai, Alaska, in July, 1917, and one female taken at Savonoski, Naknek Lake, Alaska, in June, 1919

Porphyrops borealis, new species

Male Length 4–4 5 mm, of wing, 3 3–4 mm Face narrow, black Palpi black Front green, nearly covered with white pollen Antennæ black, third joint scarcely longer than the two basal joints taken together, arista about as long as the antennæ Beard black, sometimes more brown Eyes with pale hairs

Thorax and abdomen green with whitish pollen, the former quite shining Hypopygium (Fig 6) black, its outer lamellæ long and narrow, yellowish brown, plain, as long as the height of the hypopygium and fringed with long pale hairs, the inner appendages very small, black, with a hair at tip

Coxæ black with black hair, the middle pair with a black thorn at tip Femora black, anterior pair with long black hair on their posterior surface, middle pair with several black bristles on each side near the tip, posterior pair with two preapical bristles Fore and middle tibiæ yellow, the former with two, the latter with three rows of long bristles Hind tibiæ blackish or yellowish brown with a yellow glabrous line on upper surface, and with two rows of rather stout bristles Fore tarsi longer than their tibiæ, darkened from the tip of the first joint, which is about twice as long as the second and a little enlarged at tip, last three joints of about equal length Middle tarsi black from the tip of the first joint, slightly longer than their tibiæ, the first joint nearly as long as the three following taken together, fourth scarcely longer than the fifth Hind tarsi black, each joint a little longer than the one following it Halteres yellow Calypters dark yellow with yellowish cilia, which appears black in certain lights

Wings grayish, third vein considerably but evenly arched, last section of fourth vein bent near its middle, ending in the apex of the wing, last section of fifth vein scarcely twice as long as the cross-vein, hind margin of the wing rather evenly rounded

Female What seems to be the female of this species has the face gray, the suture below the middle, making the lower part of the face small, it is a little pointed at the center of its lower edge, palpi black, rather small, their tips yellowish, beard white, scanty, fore coxæ with yellow hairs, sometimes with one or more black hairs at tip, femora and tibiæ yellow, hind femora more or less black at tip or along the upper edge, middle and hind femora with preapical bristles, fore tarsi scarcely as long as their tibiæ, the first joint as long as the remaining four taken together, middle tarsi fully as long as their tibiæ, first joint as long as the three following joints taken together, hind tarsi black, first and second joints of nearly equal length Wings gray, slightly brownish in front of second vein, third vein very slightly recurved at tip, last section of fifth vein more than twice as long as the cross-vein

Described from six males and eight females, taken at Savonoski, Naknek Lake, Alaska, in June and July, 1919, and two males taken at Katmai, Alaska, in July, 1917 and two males taken by J M Aldrich at Anchorage, Alaska, July 20, 1921

Xiphandrium femoratum, new species

Male Third antennal joint band-like, as long as the height of the head, its arista about one-third of the length of the third joint All coxæ black, the fore pair more or less yellow on apical half, their anterior surface with long silvery white hairs Fore femora, except extreme base and tip, and apical third or more of hind femora black, middle femora yellow The four anterior tibiæ yellow, hind tibiæ and their tarsi wholly black Outer hypopygnal lamellæ elongate, slender triangles with a slender stem, inner appendages somewhat shovel-shaped, not at all clubbed, rather obliquely truncate at apex

Four males were taken at Kodiak, Alaska, in June, 1917, and one female at Katmai, Alaska, in Augusta, 1917

This is more fully described in transaction of the American Entomological Society, Vol xlviii, p 81

Since sending off the specimens I have decided to place as a distinct variety a form of this that has a thumb-like projection on the inner appendages near the middle of their length, calling it var *pollex*, both are found in the Alaska material, as also in my Wells, Nevada, material.

Sympycnus aurifacies Van Duzee

Male Length 1 7 mm of wing 2 mm Face narrow golden yellow Front dark blue or violet Palpi yellowish very small Two basal joints of the antennæ orange yellow third joint black twice as long as wide rather pointed at tip Lower orbital cilia white short

Thorax greenish brown dorsum with a median green line and a poorly defined purple stripe on each side of the line sometimes the dorsum is so thickly covered with brown pollen as to conceal these lines scutellum blue or violet green around the edges with one pair of large bristles Abdomen short depressed bronze green dull its hairs black Hypopygium almost entirely concealed Fore coxæ wholly yellow appearing bare but with a few minute yellowish hairs Middle and hind coxæ blackish Femora and tibiæ wholly yellow and with very short hairs those on the sides and lower surface of the femora are yellow and so minute that they appear bare Middle femora with a small bristle on each side near the tip hind pair with one preapical bristle All tibiæ with a few very small bristles All tarsi black from the tip of the first joint anterior pair about one and a half times as long as their tibiæ the first joint nearly as long as the two following joints taken together the last three joints each a very little longer than the following joint Middle and hind tarsi scarcely as long as their tibiæ hind basitarsus scarcely as long as the following joint Calypters their cilia and the halteres yellow

Wings tinged with brownish gray veins black fourth vein ending in the apex of the wing last section of fifth vein twice as long as the cross vein

Female Face nearly twice as wide as in the male golden yellow upper edge of first two antennal joints black third joint black smaller than in the male Fore coxæ blackened on the front surface at base sometimes almost to their tips hairs on fore coxæ and legs a little longer than in the male those on the sides of the femora mostly black posterior knees very slightly blackened Wings as in the male

Described from three males and five females taken at Savonoski Naknek Lake Alaska in July 1919

Medeterus viridifacies new species

Male Length 3 mm Face bright green but not shining with a transverse band of gray pollen across its center Palpi large black Front opaque brown First two antennal joints yellow third black small Lateral and inferior orbital cilia yellowish

Thorax brown dorsum opaque with brown pollen pleuræ more tinged with green scutellum with four large bristles acrostichal bristles small three black bristles above fore coxæ Abdomen black quite shining Hypopygium black rather small its appendages black

Legs and feet altogether black fore coxæ with a row of black bristles on outer anterior edge hairs on the legs very minute second joint of hind tarsi about one and a fourth times as long as the first Calypters yellow with a black edge and black cilia, halteres black

Wings a little grayish, veins black, fourth and fifth veins more brown, last section of fifth vein nearly reaches the wing margin and is one and a fourth times as long as the cross-vein

In the female the thorax is more shining than in the male

Described from two males and one female, they were taken at Savonoski, Naknek Lake, Alaska, the males in July and the female in June

Medeterus bicolor, new species

Male Length, 2 5–2 7 mm Face dark green, with bronze reflections to nearly black Palpi black Front nearly opaque with brown pollen Lower orbital cilia white Antennæ wholly black, third joint small, a little pointed at tip

Thorax slightly greenish, dorsum with brown pollen which is more grayish white on its margins Acrostichal bristles distinct, bristles above the fore coxæ small, black, scutellum with four large bristles, the median pair the longest Abdomen dark green, almost black, shining, its hairs yellow Hypopygium black with yellow appendages

Fore coxæ with pale hairs on their anterior surface Legs and feet black, knees yellow Middle femora with long yellowish white hairs below for their entire length, hind pair with a row of black hairs or slender bristles on outer surface which are longest near the tip Hind tarsi with the second joint nearly one and three-fourths times as long as the first Calypters yellow with a brown edge and yellow cilia Halteres yellow

Wings grayish, costa black, veins brown, last section of fifth vein nearly reaching the wing margin and scarcely twice as long as the cross-vein

Female About as in the male, except that the second joint of hind tarsi is only about one and a half times as long as the first and the last section of the fifth vein is a little shorter

Described from four males and five females taken at Savonoski, Naknek Lake, Alaska, in June and July, 1919

Medeterus parvus, new species

Male Length, 2 5 mm Face, head, thorax, abdomen and legs about as in *bicolor*, except that the second joint of hind tarsi is only about one-third longer than the first joint, the middle femora are without the long yellow bristles below, and the hind femora have a row of bristle-like hairs on lower outer edge and a row of several slender black bristles above them on outer surface It also has the wings a little narrower near the base, the cross-vein shorter, making the last section of fifth vein fully twice as long as the cross-vein The second joint of hind tarsi nearly one and a third times as long as the first

Described from one male and two females, all from Savonoski, Naknek Lake, Alaska, taken in June, 1919

TABLE OF NORTH AMERICAN SPECIES OF HYDROPHORUS

1 Knobs of the halteres wholly yellow 2
Knobs of halteres infuscated, at least on outer surface 21

2 Postvertical bristles in a row of six or more 3
Postvertical bristles only two as usual 7

3 Scutellum with two or more pairs of large bristles 5
Scutellum with only one pair of bristles (western species) 4

4 Face nearly or quite opaque, whitish, fore tibia and basitarsus plain *gratiosus* Ald
Face almost wholly shining metallic, fore tibia and basitarsi each with a distinct bend, that of the former very conspicuous *curvipes* V D

5 Propleura with a bunch of several black bristles, (western) *plumbeus* Ald
Propleura without or with only one black bristle 6

6 Face and body wholly covered with yellow pollen, which is very thick in the male, (eastern) *intentus* Ald
Pollen thinner and mostly gray or silvery gray, at most only slightly tinged with yellow, (western) *argentatus* V D

7 Without a black propleural bristle 8
With one black propleural bristle 13
Usually with two or more black propleural bristles, unusually long yellow hair on the fore coxæ and femora, (Alaska) *flavihirtus* new species

8 Second vein very short, ending opposite the cross-vein, (Tex , Kans , S D , Colo) *cerutias* Loew
Second vein normal, ending far beyond the cross-vein 9

9 Dorsocentrals minute, white, (Wyo , Kans , S D , Calif) *canescens* Wh
Dorsocentrals black 10

10 Middle femora with long white hairs or bristles on lower surface, cheeks almost invisible middle tarsi of male with the fifth joint a little enlarged (Mich) *agalma* Wh
Cheeks distinct, middle femora without or with only very short white hairs below (Alaska) 11

11 Wing with the cross-vein distinctly infuscated, usually forming a brown spot and sometimes with a very faint spot on the last section of fourth vein *pectinipes* new species.
Wings without spots on the wings 12

12 Middle tarsi of male plain hairs on the dorsum of the abdomen wholly or mostly white *canites* new species
Middle tarsi of the male with the fifth joint somewhat flattened, nearly twice as long as fourth, hairs on the dorsum of the abdomen black, except some on the hind margins of segments *pectinipes* new species

13 Face opaque with pollen, the ground color not showing through 14
Face with more or less metallic color showing through the pollen 15

14 Pollen of face pure white wings clear, without spots on the veins, veins broadly yellow at base, (U S) *aestuum* Loew
Face ochre yellow, wings with a very conspicuous spot on the cross-vein and another on the last section of fourth vein veins scarcely paler at base (Canada) *glaber* Walk

15 Tips of fore tibiæ in both sexes with an acute angle produced toward the femora fore coxæ with from one to three black bristles on outer upper corner 16
Tips of fore tibiæ not or but slightly angulated 17

16 Wings without spots on the veins, face usually very bright blue-green as far down as the suture, (U S) *philombrius* Wh
Wings with the cross-vein infuscated, usually forming a spot, upper part of the face with the ground color showing through a little, (Alaska) *pectinipes* new species

17 Fore tibiæ of male notched on inner side at two-thirds their length; female with quite long bristles below on apical half of fore femora, (western states, Alaska) *breviseta* Thom.
Fore tibiæ of male not notched; fore femora of female with very small bristles below, or none at all 18
18 Wings with a conspicuous spot on the cross-vein and another near the middle of the last section of the fourth vein. (Alaska) 19
Wings clear or nearly so, without spots on the veins 20
19 Hairs on fore coxæ whitish or very pale yellow, delicate. (Alaska) *viridifacies* new species
Hairs of fore coxæ deep yellow, quite long and bushy. (Alaska) *flavihirtus* new species
20 Size 3 mm., pleuræ with rather thick white pollen, (Wyo., Colo.) *sodalis* Wh.
Size 4.5 mm., pleuræ with thin yellowish pollen, (N. M., Wyo., Colo.) *magdalenæ* Wh.
21 Wings with a brown spot on the cross-vein and another on last section of fourth vein 22
Wings without spots on the cross-vein 34
22 Face opaque with pollen, the ground color not showing through 23
Face showing some metallic color, the pollen not wholly concealing the ground color 27
23 Beard composed of black bristles and some yellowish hairs; face of female yellowish brown with a gray spot on each side below the suture; male with a small protruberance below near the tip of the fore femora, (Alaska) *signiferus* Coq.
Beard yellowish, there may be a few black bristles under the neck 24
24 Fore coxæ with no black bristles, (Wyo.) *algens* Wh.
Fore coxæ with black bristles besides the row at tip 25
25 Wings with the spots faint, fore coxæ with a row of about 16 spines, longest towards the tip, running out proximally, (eastern) *pirata* Loew.
Wings with the spots very conspicuous 26
26 Fore coxæ with an irregular row of little black bristles on outer anterior edge; pollen of inner portion yellowish or yellowish brown, contrasting with the white pollen of the outer portion, pollen of face yellowish brown, (eastern states and Colorado) *chrysolgus* Walk.
Fore coxæ with two irregular rows of black bristles or stiff hairs outside of the center of the anterior surface, their pollen wholly whitish; pollen of face white, (Alaska) *brevicauda* new species
27 Propleuræ without a black bristle, having only pale hairs above fore coxæ and sometimes a yellowish bristle, (B. C.) *phoca* Ald.
Propleuræ with a black bristle 28
28 Middle femora with long black bristles on anterior ventral surface, 4-5 in male and 2-3 in female, (Alaska) *pilitarsis* Mall.
Middle female without bristles at base 29
29 Females 30
Males 31
30 Fore femora with about seven small spines below, (Wyoming) *algens* Wh.
Fore femora without spines below, (Alaska) *propinquus* new species
31 Fore femora plain, without a protuberance below near the tip, (Wyoming) *algens* Wh.
Fore femora with a protruberance below near the tip, preceded by about five spines in a group, (Alaska) 32
32 Many black bristles mixed with the beard, Alaska, (as determined by Malloch) *signiferus* Coq.
Beard without black bristles, excepting sometimes a few under the neck 33
33 Fore coxæ with pale hairs, (Alaska) *propinquus* new species
Fore coxæ with the hairs wholly or almost wholly black, (Alaska) *nigribarbus* new species

34 Fore coxæ with black bristles or spines besides those at tip 35
Fore coxæ without black bristles except at tip (sometimes these are missing 40
35 Face wholly opaque with pollen 36
Face showing some metallic color there being no pollen on upper part or the pollen thin 37
36 Fore coxæ with a row of black spines longer above running out apically (eastern) *parvus* Loew
Fore coxæ with a row of black spines or bristles longer towards the tip running out basally (eastern) *pirata* Loew
The row of bristles on fore coxæ only reaching about half their length from the tip and of nearly equal length throughout (Alaska) *brevicauda* new species
37 Fore coxæ with black hairs and also a row of slender black bristles on outer edge of anterior surface male of *nigribarbus* new species
Hairs of fore coxæ white or yellowish 38
38 Hairs of fore coxæ rather long yellow a row of 7 10 black bristles of nearly equal length on outer side of anterior surface of apical half of fore coxæ (Alaska *brevicauda* new species
Hairs of fore coxæ minute white 39
39 Fore coxæ with a row of 5-7 long black bristles on outer anterior edge (Alaska and Northwest States) *innotatus* Loew
Fore coxæ with a row of about twelve rather short black bristles on outer edge of anterior surface middle tibiæ nearly twice as long as their very short tarsi (Alaska) Male of *fumipennis* V D
40 Face wholly opaque with brown pollen (S D Que) *extrarius* Ald
Face showing some metallic color 41
41 Cheeks forming a small lobe below the eye (Colorado) *altivagus* Ald
Cheeks narrow not forming a lobe below the eye 42
42 Fore femora of male with a small protuberance below near the tip preceded by a group of small spines (S D Mich N Y) *amplectens* Ald
Fore femora plain 43
43 Upper portion of the face bright blue green (Idaho Wash) *pensus* Ald
Upper portion of face dull only a little greenish (S D Que) *extrarius* Ald

Hydrophorus signiferus Coq

Three females which seem to belong to this species were taken at Katmai Alaska 1917, Kodiak Sept 21 1919, and Savonoski Naknek Lake in July 1919

The most marked character of this species as I see it is the numerous black bristles mixed with the berad Mr J R Malloch in the Report of the Canadian Arctic Expedition 1913-1918 Vol III p 51c describes what he considers the male of this species if he is correct it belongs to the group of species with a protuberance below the fore femora near their tip in all the species having this protuberance it is preceded by a group of five or six small blunt bristles or spines, this male he describes has numerous black bristles mixed with the beard the same as Mr Coquellitt s female had it is the only male that I know of with these black bristles and no doubt Mr Malloch s determination of this male is correct

Hydrophorus breviseta Thompson

This species is represented by 116 males and 100 females most of these were taken at Katmai on Aug 23d and at Kodiak Sept 1 a few were taken at Katmai in June

Hydrophorus canities new species

Male Length 3 5 4 mm of wing 5 mm Face wholly covered with silvery white pollen still the metallic ground color sometimes shows through a very little below the antennæ where the pollen is sometimes a little yellowish cheeks and palpi with gray pollen the former narrow and latter rather small with white hairs Beard white sometimes a little yellowish there are a few black bristles below the neck the black orbital cilia descend to the middle of the eye Occiput greenish the upper part often nearly opaque with brown pollen its orbits white pollinose one pair of postvertical bristles Front slightly greenish often opaque with brown pollen Antennæ black third joint small roundish arista black with apical half whitish

Thorax green or bronze brown with more or less coppery reflections its pollen brown scutellum sometimes steel blue it has four to six marginal bristles humeri with one or two bristles and usually several pale hairs propleuræ with a bunch of long stiff whitish hairs without a black bristle acrostichals reaching the posterior slope of the thorax dorsocentrals about ten in a row pleuræ and coxæ covered with gray pollen Abdomen green with long white hairs Hypopygium and its appendages mostly concealed

All coxæ with rather long white hair on their anterior surface but without black bristles even at tip there are no black spines Femora and tibiæ metallic green or coppery their hairs wholly white but short except a few at tip of middle femora below and on upper portion of fore femora where they are a little longer Fore femora (Figs 7 and 7 a) moderately thickened towards their base with a row of about eight blunt black spines below on basal half and an irregular row of smaller ones outside of these a row of 2 4 on apical half of front surface and one longer bristle near the tip on posterior side near the lower edge (the inner row near the base are often difficult to see) Fore tibiæ with a comb like row of very short spines on whole inner side about twenty five in number their tips not angulated towards the femora Middle femora with a few very short bristles those on the lower edge about six in number and about equally spaced along their whole length Tarsi brownish black with white hairs fore tarsi with the first joint as long as the three following joints taken together third and fifth of equal length fourth very slightly shorter than fifth Halteres yellow knob not or scarcely darker on outer surface Calypters yellow with white cilia

Wings grayish sometimes slightly tinged with yellowish brown on costal half, without spots on the veins, the cross vein not at all infuscated, veins brown, usually yellowish at base of wing costa black from the tip of first vein, yellowish at base, first vein usually wholly yellow, third and fourth veins a very little recurved at their tips, as they usually are in this genus

Female Much like the male in color Face a little wider, its pollen yellowish, except below the suture, where it is yellow in the center and almost white on the sides, especially near the suture, the fore femora are less thickened and have a scattering row of very small spines on lower anterior edge and two small bristles near the tip on lower posterior edge, still the spines are sometimes arranged about as in the male, but are shorter

Described from eighteen males and fifteen females from Alaska Eighteen specimens were taken at Savonoaski, Naknek Lake, in June, July and August, six at Kodiak, in September and June, and three at Katmai, in July, and one in August

Hydrophorus pectinipes, new species

Male Length, 4 mm , of wing, 4–4 5 mm Face widening below, covered with white pollen which wholly, or very nearly, conceals the ground color Palpi black with a little gray pollen and white hairs Cheeks wide, lobe-like, gray pollinose Front green with gray pollen Occiput green, with white pollen, one pair of postvertical bristles Beard white, I can see two black bristles under the neck, the black orbital cilia scarcely reaching down to the middle of the eye Antennæ black, third joint small, nearly round, arista black, its apical half with a whitish reflection, it is longer than the antenna

Thorax green, somewhat shining, but dulled with brownish gray pollen and with blue or coppery lines Pleuræ, coxæ, fore femora and sides of abdomen green, with thin whitish pollen Acrostichal bristles 5–6 in number, dorsocentrals 7–9 in a row, one or two humeral bristles, propleuræ with one black bristle and several pale hairs, scutellum with four strong bristles Dorsum of the abdomen shining green, with black hairs Hypopygium almost entirely concealed

Fore coxæ with delicate white hairs, no black spines at tip, but with one or two black bristles at outer basal angle Fore femora (Fig 8) thickened, not tapering much until about their middle, but slightly hollowed below in outline on basal half, with four long black bristles at base on lower posterior side and a row of about six small spines on lower anterior surface, which are continued towards the tip by several minute spines, they are nearly bare on the sides with a few pale hairs on upper and lower edges, the longest being at the base below Fore tibiæ (Fig 8) nearly straight, but rather stout, distinctly angled towards the femora at tip, with a comb-like row of erect spines on whole inner side, their hairs pale, those on anterior surface longer and having a golden reflection in certain lights Middle and hind femora and tibiæ shining green, the former with their hairs largely black, the latter with pale hairs Tarsi brownish, last joint of middle tarsi slightly widened, somewhat round in outline, longer than fourth; hind tarsi also with the last joint very slightly widened and longer than fourth joint Calypters brownish with white cilia Halteres yellow, their stem brownish at base

Wings tinged with brownish gray, cross-vein with a quite distinct brown cloud and sometimes there is a trace of a brown spot on last section of fourth vein, veins blackish, third and fourth veins slightly recurved at their tips

Female Females that probably belong here have the fore femora rather wide at base, tapering, with a minute pair of spines at basal third, fore coxæ have no black bristles at base Face narrow (the head may be compressed or shriveled), bluish gray, fore tibiæ not angulated at tip Middle tarsi normal, with the fourth and fifth joints of nearly equal length

Described from three males and one female taken at Savonoski, Naknek Lake, Alaska, in July, 1919, and two females and three males taken at Katmai, Alaska, in August, 1917, and July and August, 1919

This is much like *philombrius* Wh in the spinulation of fore femora and in having a bristle or two at base of fore coxæ, but it differs in having no black spines at tip of fore coxæ, in having the face wholly or almost wholly white opaque, the femora are not so evenly tapered, and the cross-vein is infuscated

Hydrophorus viridifacies, new species

Male Length, 2 5–3 5 mm , of wing, 4 mm , length of female, 3–4 5 mm , of wing of female, 4 5–5 mm Face usually shining green above the suture, the lower part covered with white pollen, still the ground color shows through more or less on the lower part, sometimes the pollen is a little darker in color and dulls even the upper portion of the face Front green, nearly opaque with brown pollen Occiput metallic green or coppery red, not very bright Beard white, with more or less of a golden luster, especially near the roots of the hairs, there are several black bristles under the neck, the black orbital cilia descend to the lower third of the eye, one pair of postvertical bristles Palpi black with gray pollen and white hairs Antennæ black, third joint small, somewhat round, notched at tip

Thorax bronze brown, with green coppery reflections, and with thick brown pollen, pleuræ more metallic with gray pollen, propleuræ with one black bristle and several stout pale hairs, acrostichal bristles numerous and extending to the posterior slope of the thorax, about seven dorsocentrals in each row, two humeral bristles, scutellum with four large bristles Abdomen green, dulled with white pollen, which is thick and silvery on the sides, its hairs pale Hypopygium mostly concealed

Fore coxæ with yellowish white hair and one black spine at tip on outer corner Femora and tibiæ green, their hairs pale Fore femora (Fig 11) thickened near the base, tapering, with about eight rather long spines below on basal half Fore tibiæ straight, without spines on inner side, but with several small bristles Tarsi brownish, fore tarsi with the first joint nearly as long as the three following joints taken together, fourth and fifth of nearly equal length Calypters and halteres yellow, the former with whitish cilia.

Wings dark grayish, veins brownish black, usually broadly yellowish at base, a brown spot on the cross-vein and another on the middle of the last section of fourth vein, these spots distinct to the naked eye, third and fourth veins a little recurved at tip

Female Face with the pollen more yellow Fore coxæ with two or more black spines at tip Fore femora without spines below, or with one very minute one near the middle, hairs on the middle and hind femora partly black Otherwise about as in the male

Described from 25 males and 32 females from Alaska These were taken at Katmai, July and August 23, 1917, and at Savonoski, Naknek Lake, in June, July and August, 1919

The typical form has the face bright green above with white pollen below in both sexes, but many specimens that I cannot separate have the pollen more yellow and covering most of the face

This form is something like *chrysologus* Walker, but that species has the front and face wholly opaque with yellowish brown pollen, and the fore femora has two rows of rather large spines below, all of which is different in this species The knobs of the halteres are also blackish in *chrysologus*, while in this species they are wholly yellow I have a specimen which I took at Kearney, Ont, which I have determined as *glabor* Walker It is very nearly like *Chrysologus*, but is smaller and has the halteres wholly yellow, and has the face very much narrowed above, much more so than in chryoloffus

Hydrophorus propinquus, new species

Male Length, 4–5 mm., of wing, 5 mm Face wide, with white pollen, the metallic ground color showing through on upper portion, usually nearly down to the suture, ground color green, but just below the antennæ it is more bronze and has thin brownish pollen. Palpi black with black hairs Front wholly opaque brown. Occiput green, with a little brown pollen just back of the vertex, along the orbits and on the narrow cheeks the pollen is gray Beard yellow, there are some black bristles under the neck, the black orbital cilia descend to about the lower fifth of the eye, one pair of postvertical bristles Antennæ black, third joint rather small, rounded, arista longer than the antennæ, with a whitish reflection at tip

Dorsum of thorax polished brown or blackish, a little green on lateral edges where there is thick brown pollen, pleuræ more green with thick white pollen on lower portion, two humeral bristles, about ten dorsocentrals in each row, scutellum with two marginal bristles, propleuræ with a cluster of pale hairs just above the fore coxæ and above these a large black bristle. Abdomen green, upper surface shining with coppery reflections and black hairs, its sides thickly white pollinose and with some long pale hairs, venter grayish, with a few pale hairs Hypopygium concealed, its outer lamellæ projecting posteriorly, large, oval, fringed with little white hairs, its other appendages usually wholly concealed

Anterior surface of fore coxæ green, with white pollen and yellowish hairs, on the outer edge of apical half there is a row of about six black bristle-like hairs and at tip about four more, middle and hind coxæ black with thick white pollen, middle pair with the hairs on outer half of anterior surface black, those on inner edge and at tip long and pale Femora and tibiæ green, their hairs largely black, still there are many pale ones on upper and lower surfaces of the middle and hind pairs of femora, and those on the tibiæ may be largely pale Fore femora (Fig 9) not much thickened, the lower surface on its anterior edge with a row of short spines, near the tip there is a small protuberance, preceded by six long stout bristles and one long bristle at tip, seen from above these femora are quite crooked, their tibiæ rather stout, with a small tubercle near the base on anterior surface, the row of black spines on inner surface are erect and rather long, not quite reaching the tip, the anterior surface of apical half or more with conspicuous yellow hairs, their tips normal, not angulated towards the femora Tarsi blackish, plain Halteres yellow, with the outer surface of the knob blackened Calypters brownish yellow, with pale yellow cilia

Wings grayish, cross-vein clouded with brown, a small brown spot near the middle of the last section of fourth vein, veins wholly blackish, third and fourth veins slightly recurved at their tips

Female Face with brown pollen, the ground color showing through above Fore coxæ with the hairs partly black Fore femora without spines below, except two or three small ones near the tip, they have a very slight protuberance below near the tip (easily overlooked), fore tibiæ plain, with a few slanting spines on inner surface Otherwise about as in the male

Described from 32 males and 28 females from Alaska They were taken at Katmai, in July and August, 1917, Kodiak, June, 1917, and September, 1919, and Savonoski, Naknek Lake, in July and August, 1919

Hydrophorus nigribarbus, new species

The male is very much like the male described above, except that the hairs of the fore coxæ are wholly black, those on middle coxæ also seem to be wholly black, the spines on the lower surface of fore femora are less conspicuous, the wings are conspicuously tinged with brown along the front and the veins are margined with brown, the fore femora are formed about as in the preceding species The specimen from Savonoski has the wings nearly clear except the spots on the veins

Described from five males taken at Katmai, Alaska, in July and August, 1917, and one male taken at Savonoski, Naknek Lake, Alaska, in August, 1919

The female of this is probably about the same as that of the species above and no doubt are mixed with those of that species, but I cannot separate them

This makes seven species described with nearly the same form of male fore femora, that is with a protuberance below near the tip, proceeded by a few blunt spines Three are from Europe and four from North America, the European species are *borealis* Loew, *albiceps* Frey, and *magnicornis* Frey, from America we have *amplectens* Ald, from Brookings, S D, Battle Creek, Mich, and Essex Co, N Y This differs from all the other species in having the wings clear, without spots on the veins, and it also differs from all others in having the pollen of the face brownish yellow, except *signiferus* Coq, the male of which has the pollen more or less yellowish brown (male as determined by Malloch), but in that species the beard is composed of black bristles mixed with pale hairs, in all the other six species the beard is pale, with sometimes a few black bristles under the neck, all the other five species have the pollen of the face white or silvery, *albiceps* has the face wholly covered with white pollen, the other four show the metallic ground color on the upper part of the face, *Magnicornis* differs from the others in having the third antennal joint unusually large, in all the other forms the third joint is small or rather small and round or nearly so, *propinquus* differs from *borealis* and *nigribarbus* in having the hairs of the fore coxæ wholly pale and those on middle coxæ partly pale Perhaps *nigribarbus* described above will prove to be *borealis*, but it differs from Dr Lundbeck's description of that species in having the wings brown in front and in lacking the dense hair on fore femora, still they must be compared to make sure that they are not one species, especially as both are arctic

Hydrophorus flavihirtus, new species

Male Length, 4 2 mm , of wing, 4 5 mm Face broad, but little narrowed above, dark but shining green, with only a little brownish yellow pollen on the sides and lower edge of the portion below the suture Palpi black, with yellow hairs Front opaque brown Occiput more metallic, with one pair of postvertical bristles, about twelve black orbital cilia on each side, reaching down to the middle of the eye Beard golden or orange yellow, with black bristles under the neck No cheeks visible Antennæ black, third joint small, about as long as wide, truncate at tip, arista nearly twice as long as the antennæ

Dorsum of thorax metallic brown with green reflections and brown pollen, pleuræ more green with yellowish brown pollen, propleuræ with two or three black bristles and several pale hairs (these black bristles may have a yellowish reflection in certain lights) Abdomen green, with black hairs above and a very few white ones on the sides at base, its lower edges with thick white pollen Hypopygium concealed its outer lamellæ nearly as long as the hind basitarsus, not half as wide as long, fringed with a few small white hairs

Fore coxæ greenish, with a little yellow pollen and long, stiff, almost golden yellow hairs on anterior surface, there are several small black spines at tip Fore femora (Fig 10) considerably thickened at base, with a row of about eight rather long black spines on basal half below, and about the same number of thinner ones in a row on lower posterior edge of apical half, besides these they have black hairs on the sides and abundant, rather long, yellow hair all over Fore tibiæ with a row of rather short, erect spines on lower or inner side and longer black bristles above, also numerous pale hairs on upper and lower edges and some black hairs on the sides Middle and hind femora and tibiæ green, with black and pale hairs, those on lower surface mostly pale and longer Tarsi blackish, of the usual form Calypters and halteres dark yellow the former with yellow cilia, the knobs of the halteres scarcely darker on outer surface

Wings blackish gray, tinged with brown in front of third vein, with a dark brown spot on the cross-vein and another on the middle of the last section of the fourth vein, veins wholly blackish, third and fourth veins nearly parallel towards their tips

Female Agrees with the male in color Hair on the fore femora and coxæ unusually long and yellow, as in the male, no black spines below on the fore femora

Described from one pair taken at Savonoski, Naknek Lake, Alaska, in July and August, 1919, and one female taken at Katmai, Alaska, in August, 1917

Hydrophorus brevicauda, new species

Male Length, 4–4 2 mm , of wing, 5–5 3 mm Face usually quite bright green above, with white pollen covering most of the lower part, but sometimes the ground color is nearly or wholly concealed by white pollen Palpi with yellowish pollen and both black and yellow hairs on the upper surface Cheeks wide, lobe-like Front opaque dark brown, still sometimes the green ground color shows through a little Occiput metallic with the orbits and cheeks gray pollinose, one pair of postvertical bristles Beard golden yellow, long, but not very abundant, with several black bristles under the neck, black orbital cilia descending nearly to the lower fourth of the eye Antennæ black, third joint small, about as long as wide, truncate and with a notch at tip

Dorsum of thorax bronze brown, its lateral sides quite bright green, pleuræ greenish, with its pollen a little brown above, white below, acrostichal bristles long and reaching the posterior slope of the thorax, 10–12 dorsocentral bristles in each row, propleuræ with long bristle-like yellow hairs and one large black bristle Abdomen green, with black hairs above and abundant yellow hairs on the sides for its entire length Hypopygium concealed, its outer lamellæ usually projecting about as far as the length of the third antennal joint, sometimes a little more when they are fully extended

Fore coxæ green, with white pollen, their anterior surface with bright yellow hair, which is much longer on outer half, especially at base, and with a row of black bristles on outer edge of apical half, these are usually eight in a row, there are also a few black spines at tip, middle coxæ with their hairs partly black and partly yellowish Fore femora a little thickened near the base, their hairs largely black, they have a few very small spines below on basal half, which seem to be in two irregular rows, the posterior one continued nearly to the tip by little hair-like black bristles Fore tibiæ with a row of very short, erect spines on whole inner side All femora and tibiæ metallic green Tarsi blackish Calypters yellow, their cilia pale yellow Knobs of halteres black, their stem and sometimes the inner surface of the knob more yellowish

Wings dark gray, without spots on the veins, veins black, not paler at the base of the wing, third vein considerably bent near its tip, which is scarcely recurved, last section of fourth vein nearly straight

Female Pollen of the face more yellowish brown, upper part of face metallic green, beard and fore coxæ with the same deep yellow hairs as in the male, fore coxæ with fewer black spines on outer edge, fore femora without spines below, fore tibia without the row of spines on inner side, wings about as in the male

Described from eleven males and nine females, all taken at Savonoski, Naknek Lake, Alaska, in July and August, 1919

This is like *flavihirtus*, new species, in having the beard almost golden yellow and the fore coxæ with long yellow hair The male differs in having short outer lamellæ, much shorter hair on fore femora, in having a row of small black bristles on apical half of fore coxæ, the third vein is more abruptly bent near the tip, and the wings are without spots on the veins The females differ in the wing characters in the same manner as the males.

Although there is a great difference in the amount of white pollen on the face of several of the males, still I think they are all one species

Dolichopus solidus, VanDuzee, Cole & Aldrich

One male of this species was taken at Savonoski, Naknek Lake, Alaska, in July, 1919

This species was described from a single male from Alaska, which was in very poor condition, all the tarsi being partly or wholly broken off, so I will give the following characters not contained in the original description of the species published in the U S National Museum Bulletin 116, p 104, 1921

Fore tarsi a little more than one and a fourth times as long as their tibiæ, first joint scarcely as long as the two following taken together, second and third joints of nearly equal length, fourth and fifth joints compressed and fringed on each side, forming together a nearly round tip to the tarsi, the two joints of equal length In this specimen the hind tibiæ are nearly wholly blackened and considerably thickened, the middle tarsi infuscated almost to their base, the whole of the legs and feet being darker than in the type specimen The cilia of the calypters is decidedly black in certain lights, in other lights it is quite yellowish, in the type it was black, if yellow in any light I did not notice it

Dolichopus rupestris, Hall

Thirteen examples were taken at Katmai, Alaska, in August, 1917

Dolichopus renidescens, Melander and Brues

Eighteen examples were taken at Savonoski, Naknek Lake, Alaska, twelve in July and six on August 1, 1919 This is the first record of this species from Alaska

Dolichopus discifer, Stam

One specimen was taken at Katmai, Alaska, in August, 1917

Dolichopus deterus, Loew

One specimen was taken at Savonoski, Naknek Lake, Alaska, in 1919 This is the first record of the species from Alaska or any of the western states

Dolichopus litoralis, Van Duzee, Cole & Aldrich

One example was taken at Katmai, Alaska, in August, 1917 This was described from two males taken in the state of Washington

Dolichopus sp

One female taken at Katmai, Alaska, in August, 1917 This would run in the table of females in the U S National Museum Bulletin 116, 1921, on page 30, couplet 60, to *xanthocnemus*, but is a stouter species and the pollen of the face is more gray, not white, the middle femora are also deep black, with only their tips yellow, in *xanthocnemus* the middle femora are broadly yellow at tip, the yellow shading into the black This seems to belong to an undescribed species

Dolichopus uxorcula, Van Duzee, Cole & Aldrich

One male and four females were taken One female at Katmai, Alaska, in July, 1917, and three females and the male at the same place in August, 1917

This was described from females, the following is a description of the male

Length, 3 5 mm , of these females, 4 mm Face moderately wide, silvery white, palpi yellow Front shining green First antennal joint yellow, with the extreme upper edge a little brown, second and third joint black, third a little longer than wide, pointed at tip, lateral and inferior orbital cilia white

Hypopygium black, its lamellæ of moderate size, somewhat oval, but tapering into the stem, white with a rather wide black apical border, jagged and bristly at apex

Fore coxæ wholly yellow, their anterior surface covered with silvery white pollen and minute black hairs, a few on the outer edge yellow, middle tibiæ with an elongated silvery or opalescent spot on upper surface at tip which extends for about one-fourth their length The black hairs on the sides of hind femora very small, but extending nearly to the lower edge, no longer hairs below Hind tibiæ black at tip for one-sixth their length, only a little thickened, the glabrous streak on upper edge between the rows of large bristles can be traced, but is indistinct

Middle tarsi about as long as their tibiæ, wholly deep black, first joint without a bristle above, as long as the two following taken together Hind tarsi wholly black.

Wings grayish hyaline, costa not or scarcely enlarged at tip of first vein, last section of fourth vein a little bent before its middle, nearly parallel with third towards its tip, anal angle very prominent

The female has the first two antennal joints and part of third yellow, while this male has only the first joint yellow, still I have no doubt of their being the same species

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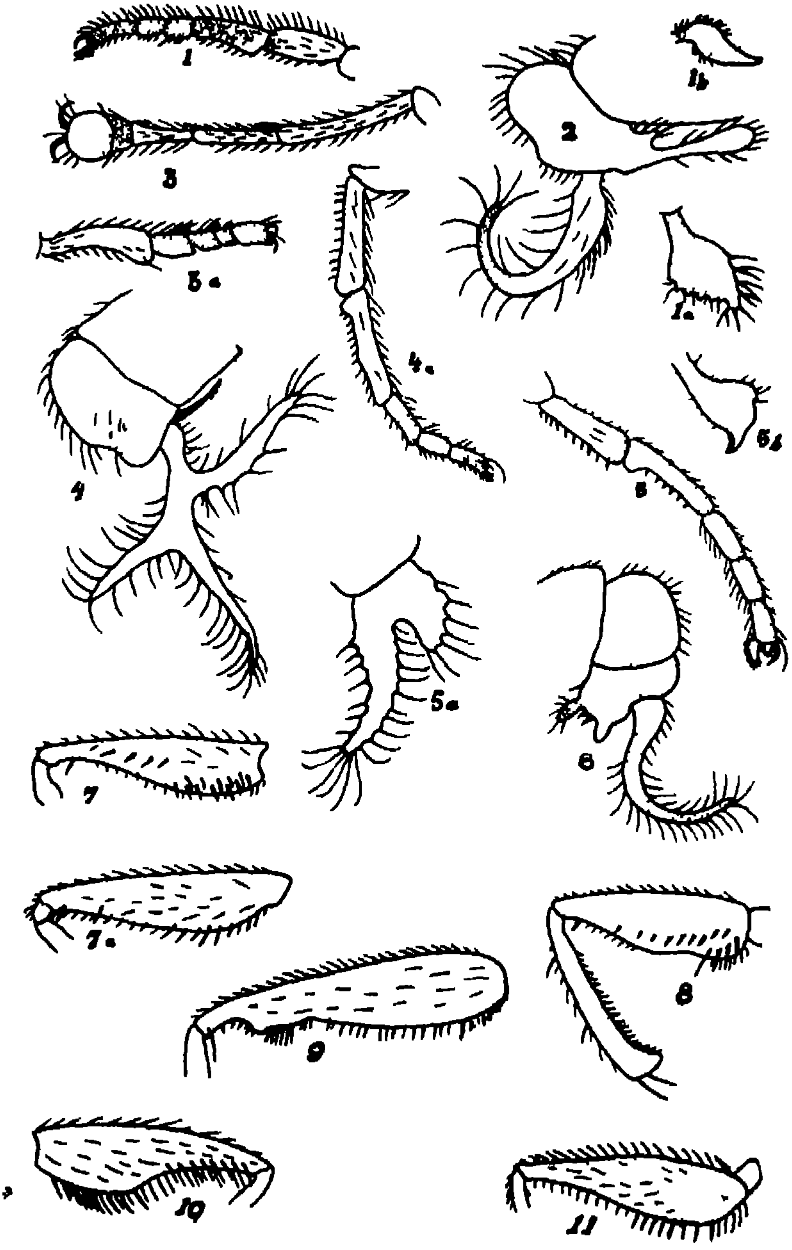
EXPLANATION OF PLATE

Fig 1 *Porphyrops consobrinus* Zett Fore tarsus of male
Fig 1a Outer lamella of same
Fig 1b Inner appendage of the hypopygium of same
Fig 2 *Porphyrops elagantula* Meig , hypopygium of male
Fig 3 *Porphyrops crassipes* Meig , middle tarsus of male
Fig 3a Fore tarsus of male of same
Fig 4 *Porphyrops tricaudata*, new species, Hypopygium of male
Fig 4a Fore tarsus of same
Fig 5 *Porphyrops nigra*, new species, fore tarsus of male
Fig 5a Outer lamella of same
Fig 5b Inner appendage of hypopygium of same
Fig 6 *Porphyrops borealis*, new species, hypopygium of male
Fig 7 *Hydrophorus canities* new species, fore femora of male anterior side
Fig 7a Posterior side of same
Fig 8 *Hydrophorus pictinipes*, new species, fore femora and tibia of male
Fig 9 *Hydrophorus propinquus* new species, fore femora of male
Fig 10 *Hydrophorus flavihirtus* new species, fore femora of male
Fig 11 *Hydrophorus viridifacies*, new species, fore femora of male

Diptera of the Family Dolichopodidæ
M C VanDuzee

PLATE I



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A STUDY OF THE FOOD OF THE MINNOW CAMPOSTOMA ANOMALUM *

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INTRODUCTION

Study of the food of minnows is receiving more and more attention, (Breder and Crawford, 1922, p 287), for the importance of the minnows as food of larger fresh water fishes, involves the need of getting at the sources of the minnows' nourishment, which must be present in sufficient abundance if the minnows and consequently the larger fishes are to thrive

In this paper the food of the minnow Campostoma anomalum is considered This fish is commonly called the stone roller, but is also known by such names as stone-lugger, stone-toter, dough belly, rot-gut minnow, greased minnow greased chub, steel-backed minnow, steel-backed chub, and mammy It is a common fish in Ohio

This minnow inhabits small rivers and creeks primarily, is found to great extent in moderate to swift current, and above rocky and pebbly bottom much oftener than above muddy or oftener even than above sandy bottom It is a fish particularly of the riffles environment

While the writer was a member of a state fish survey party, (summer of 1920, 1921), working under direction of Prof R C Osburn, for the Ohio Division of Fish and Game, a very great many of this species were taken with the seine These, as well as some sent by the party in the field in the summer of 1922, were available for the writer's use, and the latter during the same summer, collected many young specimens in the vicinity of Columbus

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* Contribution No 73, from the Department of Zoology and Entomology, Ohio State University

The writer is particularly indebted to Dr R C Osburn, as well as to Mr E L Wickliff and other members of the survey party, and to several other friends and colleagues who helped, seine

For the last two years the writer was engaged in a research on some anatomical features of this interesting species, the results of which work will be published elsewhere Some 600 specimens were utilized, which had come from a total of 39 Ohio counties, and most were available for food examination What was thought to be a sufficiently large number, were examined, and all of these are tabulated and discussed below

PREVIOUS STUDY

The food of Campostoma has apparently been studied previously in only a few specimens Forbes, (1883, and reprint, 1912, pp 69-72), gives the only idea of the nature of the food, and these observations seem to have been used without further investigation later, (Forbes and Richardson, 1908, p 111)

> "Of the great number of specimens available for dissection only nine were studied, since the contents of the intestine were found so uniform in character * * * The intestine was invariably filled from end to end with a black slimy matter, which, * * * was found to consist almost wholly of fine mud * * * It (the organic matter) made on an average only about one-fourth of the contents of the intestine, the remainder consisting of finest particles of sand and clay Not far from one-fifth of the whole amount was of vegetable origin, consisting chiefly of filamentous algæ, mingled with a few diatoms, but comprising occasionally minute fragments of other kinds of vegetation also The only animal objects noted were occasional Chironomous larvæ and Difflugia Sometimes the intestine was wholly filled with almost pure mud, in which no organic structures whatever could be detected Date and locality seemed to make no material difference in the food of this fish, which should evidently be classed as limophagous "

FOOD HABITS OF CAMPOSTOMA

Campostoma is a bottom feeder for the most part The head is somewhat sucker-like in general shape, the mouth being ventrally directed, and thus in striking contrast to the more definitely terminal or forwardly directed mouth of many other minnows, such as Notropis, and Semotilus for instance, which are fitted for carnivorous prehension The lips of Campostoma are fleshy and suggest the sucker lip of not too pronounced type

Campostoma is particularly adapted to feeding on the diatomaceous and other growths adhering to stones on the bottom of the riffles The dust fine detritus is no doubt easily ingested, and adhering material appears to be taken about as readily The writer has observed some Campostoma feeding on stones in a natural habitat, and more extensively in a laboratory aquarium

There were very few large stones in the aquarium, some of the bottom was covered with pebbles, and a small part was bare Occasionally a specimen was seen to feed on the bare bottom part, where there was a thin film, probably diatomaceous More frequently they were probing around among pebbles, very likely feeding Both algæ and diatoms were thriving there. In the absence of current, the aquarium was entirely unlike their natural habitat There was no great amount of loose detritus present, in which respect the environment was similar to that of many swift stream bottoms, where the current would remove loose materials Most of the feeding was witnessed on the sides of the aquarium For some months, (during which repeated observations were made) the glass walls of the aquarium were covered with a rich plant growth, largely diatomaceous While this upright position does not seem normal, it seemed to do very well, and certainly presented the richest supply of food The fish would frequently feed there by coming up against the glass surface, moving along it for a distance of a half inch or so, apparently swallowing as much of the diatomaceous deposit as possible, and then leaving the place for the time being Short, narrow, cleared spaces, where they had removed the film, could be seen While a number of artificial conditions existed here, so that the food supply most likely did not prove normal, or adequate, as indicated by the subnormal rate of growth of aquarium fishes, the manner of feeding could be adequately studied in this way

METHOD OF EXAMINATION OF FOOD

Because of the long type of intestine, which is small in diameter and coiled, and because of the small size of the particles comprising the intestinal contents, which are generally well packed into this long intestine, the examination of the food of the species is painstaking work In the adult fishes the intestine is relatively much longer than in the young It was seen that there was great uniformity along practically all of this length, so that only sections of it were taken, and carefully examined, but these were from near both ends and also middle parts of the canal Possibly upwards of a third of the total length was examined in all cases In all young specimens of groups 1 and 2, the entire contents were examined

The contents, of either an entire canal of a young fish, or of a short section of an older one, were completely spread out over a 3 by 4 inch glass plate, covered with a film of water, and examined with both binocular and compound microscope The high power (440 diam) was used for the final examination of all plates Considerable care was necessary in spreading out the material evenly and widely, so that all portions were clearly distinguishable, and so that estimates of the percentage composition by volume could be made with reasonable degree of fairness In all cases the determination of what percentage of the total contents any particular kind of food was, rested purely upon an estimate in which a considerable percentage of error was possible, at least where the item concerned was very small in amount and distributed in relatively small sized particles as compared with some other type of food In all cases the sum of the percentages of foods present is made to equal 100% exactly It is not to be expected that a figure of 48% or 49%, for an item in some particular fish, represents the quantity of that type of food present, any more accurately than would the figure 50%, the 1%, or 2%, may have been necessary allowance for some small item of food present There are many instances of small portions in intestinal contents, where the figure 1% seemed just about correct In some cases such figure might be excessive, but no use of fractional percentage seemed desirable or possible, and the writer wished to obviate the use of the word trace

THE SPECIMENS STUDIED, WITH TABULATION OF DATA ON INTESTINAL CONTENTS

Both young and mature specimens were examined for a study of the food of the species Five groups of 21 specimens were selected, in addition to which there was a small group of lake specimens Specimens of the five groups have been grouped according to several features, chief of which is size of fish It is logical to consider generally relation between size of fish, (and hence of its mouth), and size of particles or objects ingested though where the food consists of such minute objects, this reason may have little or no weight The specimen number is merely arbitrary, but it happens that in any collection numbers were usually assigned according to size of specimens The arrangement of individuals in a group, where they do not follow a size series, is of no significance

Group 1, (table 1) consisted of 21 very young Campostoma, including some of the smallest taken in the entire study Sixteen of these were from a very small creek, tributary to the Olentangy River, north of Worthington, Franklin County This run averaged only 2 to 3 feet wide, and was a favorable breeding place These 16 were merely a portion of the collection, taken at one date and one place, all evidently of one school, and probably of the same age This is a selection showing range in size of specimens of the collection, rather than a selection of all specimens of one size, at an extreme or average of the body length of the fishes It is notable that specimens which are very likely of one age, show such difference in size so early in life The variation in length of a large group is a continuous one, with most specimens at about the median point For groups 2 and 3 a similar selection of range in size was made

Group 2, (table 2), includes 21 young Campostoma taken entirely from Big Run, a small creek, tributary to the Olentangy River, north of Clintonville, Franklin County This is somewhat larger than the run west of Worthington It is also a favorable breeding place The specimens were collected later in the month than those of table 1, though the different length of the group as a whole compared with group 1, cannot be attributed to a definite difference in age, since one cannot tell whether the eggs hatched at the same time or not in the two places The last 15 specimens were collected at later date than the first 6, as shown in the table They belonged to the same general school very likely

Group 3, (table 3), is likewise a selection of 21 young specimens from Big Run, but collected later in the summer when they were larger

Group 4, (table 4), includes 21 specimens of a wide distribution, from 21 different streams, although some of these streams are tributary to others represented in the table. With the exception of the north and northwestern parts, all sections of the state are represented Even a wider distribution might have been made, but for the desire to keep to a certain narrow range in specimen length The minimum of 50 mm makes all specimens in the group of greater length than those of preceding tables

Group 5, (table 5), includes 21 specimens also taken from a wide distribution, but not necessarily from the same places as those of table 4 Somewhat fewer streams are represented, since suitable large specimens were not at hand from others. Many of the largest specimens, and especially practically all those of 100 mm or greater length, are included here This selection should be a satisfactory lot for the study of the adult food

TABLE 1. INTESTINAL CONTENTS OF 21 VERY YOUNG CAMPOSTOMA.

Fish						Types Eaten with Percentages by Volume														
Specimen No.	Date of Collect	Locality—Stream	Length of Fish	Length of Intest	Degree Filled	Bacteria	Diatoms	1 Cell Blue green	1 Cell Green Algae	Filamentous Green	Leaf of Plant	Unrecog Plant Rem	Protozoa	Rotifera	Copepoda	Cladocera	Ostracoda	Fly Larvae	Unrecog Animal Rem	Inorganic
[illegible]	June 8	Run west of Worthington	13	12	½		85			5								10		
[illegible]	"	" " "	14	15	¼		30			55										15
[illegible]	"	" " "	15	17	¾		15			5				5	40	20	5		5	5
[illegible]	"	" " "	15	19	¾	5	75			5				5						10
[illegible]	"	" " "	15	19	½	5	50					10		5	10					20
[illegible]	"	" " "	15	19	1		35			30				5	10	10				10
[illegible]	"	" " "	17	26	1	2	85					3								10
[illegible]	"	" " "	17	24	1					80		15								5
[illegible]	"	" " "	18	27	1	3	80					5								12
[illegible]	"	" " "	18	22	1			3		40				2		50				5
[illegible]	"	" " "	19	30	¾			3					2	95						
[illegible]	"	" " "	19	24	¾		75	6												19
[illegible]	"	" " "	19	27	½	5	15			35	15	15								15
[illegible]	"	" " "	19	30	¾		88													12
[illegible]	"	" " "	19	27	½	5	10	10		20	20	15		5						15
[illegible]	"	" " "	20	26	1		90													10
[illegible]	June 9	Scioto—Big Run	18	22	¾	5	15	15				40		10						15
367	"	" "	18	29	¾	1	15	30				40	4							10
371	"	" "	22	35	½	5	65	10				10								10
372	"	" "	22	41	½		90													10
[illegible]	"	" "	23	36	1	4	35	25	15			5								16

TABLE 2 INTESTINAL CONTENTS OF 21 YOUNG CAMPOSTOMA

Fish						Types Eaten with Percentages by Volume										
Specimen No.	Date of Collect.	Locality—Stream	Length of Fish	Length of Intest	Degree Filled	Bacteria	Diatoms	Desmids	Filamentous Green	Unrecog Plant Rem	Cladocera	Setae of Annelida	Midge Larvae	Egg of Insect	Unrecog Animal Rem	Inorganic
375	June 14	Big Run, Chatonville	25	65	1		1			9			85			5
379	"	" " "	23	39	3/4	7	60	4	7	12						10
380	"	" " "	23	44	1	10	70	3		7						10
382	"	" " "	24	41	1/2		2			5			90			3
383	"	" " "	24	46	3/4	3	80	7								10
386	"	" " "	25	59	1	5	75	6		4						10
388	June 19	" " "	26	54	1	4	80			6						10
390	"	" "	29	97	1	1	83			4						12
391	"	"	24	48	1	1	70	10		4						15
392	"	" " "	24	38	3/4		65	3	10	10						12
396	"	" " "	25	63	1	2	70	3	10	4	3					8
400	"	" " "	26	42	1		75	4		6						15
401	"	" " "	26	57	1/2	5	55	5		20						15
405	"	" " "	27	60	3/4	1	60	4	5	10						20
407	"	" " "	28	60	3/4	5	60	4	1							30
416	"	" " "	29	73	1	2	55	5		20		3				15
417	"	" " "	28	68	1		65	5		10						20
418	"	" " "	30	74	3/4		55	6	5	10		4				20
423	"	" " "	29	64	3/4		65	5		10					5	15
424	"	" " "	29	71	1	5	50	5		15						25
427	"	" " "	29	87	1		55	8	6	10				1		20

TABLE 3 INTESTINAL CONTENTS OF 21 YOUNG CAMPOSTOMA

Fish						Types Eaten with Percentages by Volume												
Specimen No	Date of Collect	Locality—Stream	Length of Fish	Length of Intest	Degree Filled	Bacteria	Diatoms	1 Cell Blue green	Filamentous Blue green	1 Cell Green Algae	Desmids	Filamentous Green	Leaf of Plant (part)	Unrecog Plant Rem	Setae of Annelida	Midge Larvae	Eggs of Insect	Inorganic
482	July 15	Big Run Clintonville	3	111	¾		40							20				30
484	"	"	39	114	¾		0				5	5		10				30
486	"		39	138	1	6	45				2	5		20				20
524	August 5	"	39	119	¾		30					15		15				40
526	"		39	101	½		31					10		10				50
528	"	"	47	125	¾	4	30					5		20	1			40
529	"	"	42	143	1	3	40	1	1			5		20				30
530	"	" "	43	160	¾		40		10			10		15				25
531			44	15	1	5	25	1	4			20		15				30
533	"	"	43	156	¾	1	25	1	8			15		15				35
534	"	"	4	146	1	3	5	1		1		5		20		o		40
535	"	" " "	44	1 8	1	3	30	2		1	1	o		18				40
536	"	"	43	191	1	5	25				1	4	10	15				40
537	"	"	44	192	1	5	25					5		10				55
538	"	" "	4	16	¾	4	90		2			4		10				60
540	"	"	48	207	1	1	20				1	3		10				65
541	"	"	4	1 8	1	1	3				1	5		8				55
542	"	"	4	196	¾	4	3	1				10		5				50
543	"		4	209	¾	1	4				1	5		8				45
545	"	"	45	198	1	2	40					4		10			2	42
547	"	" " "	49	195	1	1	30	1				3		5				60

TABLE 4. INTESTINAL CONTENTS OF 21 CAMPOSTOMA

Fish							Types Eaten with Percentages by Volume										
Specimen No.	Date of Collect.	Locality Collect — Stream	County	Length of Fish	Length of Intest	Degree Filled	Bacteria	Diatoms	1 Cell Blue Green	Filament Blue-Green	1-Cell Green Algae	Filamentous Green	Desmids	Unrecog Plant Rem	Protozoa (Euglena)	Unrecog Animal Rem	Inorganic
63	June 17	Cold Water Run	Columbiana	52	212	1	1	50		1		2		4			42
66	" 18	N Fork, Little Beaver	Columbiana	55	245	¾	3	75					1	6			15
73	" 21	Cross Creek	Jefferson	58	355	1	1	5		1				3			90
75	" 29	McMahon's Creek	Belmont	55	275	1	2	8				5	2	3			80
77	" 30	Sugar Creek	Guernsey	56	296	1	1	3				1		15			80
84	July 7	Duck Creek	Noble	58	280	1	1	5		2				22			70
86	" 11	Newell s Creek	Washington	53	222	1	1	1		1		1		10		1	85
101	" 13	Wolf Creek	Washington	50	169	½		1						8	1		90
108	" 14	Hocking River	Athens	54	303	¾	5	15				3		13			65
119	" 16	Indian Guyan Creek	Gallia	51	130	1	1	1		3		35		10			50
127	" 24	Turkey Creek	Scioto	57	315	1	1	48		4		40		2			5
130	Aug. 1	E. Fork, Little Miami	Clermont	57	197	¾	1	7				5	1	6			80
133	" 5	4-Mile Creek	Butler	50	234	1	1	5		1				8			85
177	" 8	Little Miami River	Warren	53	302	1		5		5				10			80
199	" 8	Big Miami River	Warren	51	200	¾	1	4						5			90
204	" 29	Licking River	Muskingum	52	241	1	2	6			1		1	10			80
216	" 29	Walhonding River	Coshocton	56	265	1	1	20				10	1	15			53
227	" 28	Mohican River	Coshocton	56	250	1	1	25				1		13			60
232	" 30	Tuscarawas River	Coshocton	53	212	1	1	20		2				10	2		65
257	Sep. 12	Olentangy River	Franklin	58	250	¾	1	7	1	3				15	3		70
288	May 5	Big Walnut Creek	Franklin	55	255	1	2	60				1		7			30

TABLE 5 INTESTINAL CONTENTS OF 21 ADULT CAMPOSTOMA.

Fish							Types Eaten with Percentages by Volume												
Specimen No	Date of Collect.	Locality—Stream	County	Length of Fish	Length of Intest	Degree Filled	Bacteria	Diatoms	1-Cell Blue-green	Filamentous Blue-green	Desmids	Filamentous Green	Unrecog Plant Rem	Protozoa (Euglena)	Setae of Annelida	Egg of Insect	Midge Larvae	Unrecog Animal Rem	Inorganic
2	June 20	Hocking River	Fairfield	92	349	½	7	7			1						75		19
5	20	Hocking River	Fairfield	90	401	¾	3	35			3	4	10				5		40
10	Aug. 18	Mahoning River	Trumbull	93	507	1	3	25			3	4	10				5		50
42	July 17	Mosquito Creek	Shelby	77	282	½	5	5					15				5		70
46	" 28	Beaver Creek	Mercer	86	655	1	3	5		1	1	1	8			1			80
50	Aug 26	Deer Creek	Madison	79	416	1	2	35		2	2	4	10						45
70	June 20	M Fork Little Beaver	Columbiana	89	660	1	2	10		8		2	10						68
90	July 12	Wolf Creek	Washington	80	335	½	2	2		5			6						85
170	Aug. 17	Mahoning River	Trumbull	110	614	¾		10		1		3	6						80
202	" 12	Little Miami River	Greene	84	650	1	4	6		15			5						70
212	" 22	Licking River	Muskingum	76	441	1		10		5	5	5	5						70
213	23	Jonathon Creek	Muskingum	87	377	½		15					20						55
214	" 23	Walhonding River	Coshocton	86	422	¾	2	10		10		5	20				3		50
243	24	Killbuck River	Coshocton	75	283	¾	5	20				10	15						50
244	" 26	Tuscarawas River	Coshocton	88	471	1	8	8				1	7		1				75
256	Sep 13	Olentangy River	Franklin	83	565	1	1	10	1	10			4	4					70
266	13	Big Walnut Creek	Franklin	83	484	1	4	50				1	10						35
281	May 5	Big Walnut Creek	Franklin	87	468	1		85				1	5						9
282	5	Big Walnut Creek	Franklin	73	386	¾		55		10			5						30
491	July 17	Big Walnut Creek	Franklin	78	287	½	5	15			3	5	15	2				5	50
575	" 3	Tontogany Creek	Wood	84	634	¾	2	15		10		3	10						60

DISCUSSION OF THE FOOD

In bulk the entire intestinal contents make a compact mass, in many cases quite filling the canal, though occasionally there are parts where it is somewhat loosely placed or where short sections are clear Only where it was completely filled throughout was it considered filled and marked 1 in the column "Degree filled" in the table In very few cases examined was it as little as one-half filled Though of a generally very soft consistency, the contents were hardly "slimy" as Forbes described the mass, except where there was a large mass of filamentous algæ of slimy feel Examination showed that the soft contents were really very gritty The color was rarely black, generally some shade of brown, from light to very dark, with more or less of a greenish tinge

Inorganic matter was seen to be a considerable item in the canal contents To be sure this was not thought of as food itself, but a prevalent large percentage of it indicates that it is a normal constituent of the canal contents, and evidently something unavoidably taken in, with some mixed organic material, in its method of feeding along the bottom The inorganic material was found to be of rather uniform nature in all the specimens The largest portion of it, giving to the whole its gritty consistency, was sand in minute grains or crystals, generally so small as to be scarcely visible individually under the ordinary powers of the binocular, but prominent under the high power of the microscope There were some much larger grains, but also many smaller than the average, as if ordinary sized grains had been ground up, though there must be very little of such process going on in the alimentary canal of the fish, and very likely great masses of such triturated material exist on the bottom

A smaller portion of the inorganic constituents comprised softer material, apparently clay, in fine granules, smaller than most of the smallest gritty particles

In both groups of very young specimens (Tables 1, 2), there was not nearly as much inorganic material present as described by Forbes for this species The average is about 15% But even in the next larger group (Table 3), a much larger and somewhat uniform percentage is present In the adults and other large specimens, (Table 5 and also Table 4) the percentage is high, except in a few specimens In many it is as Forbes indicates, three-fourths inorganic and one-fourth organic These percentages are sufficient to indicate that a larger mass of inorganic material is ingested in the more wide-spread feeding of the older fish, and that the relatively small percentage of organic material furnishes enough nutriment which can be absorbed in the long course of the intestine But in younger fishes, having relatively so short an intestine, inadequate nourishment might result from such a small percentage of organic material It can hardly be concluded that the young fish selects its food, and that an early selective action is later lost The contrast, however, between the fairly uniform percentages of the young and those of the old, marks this difference as significant, whatever the cause

Among the various items of the diet is that referred to as unrecognizable plant remains (Unrecog Plant rem , as expressed in the table) A careful separation of diatoms and other plant materials from masses of inorganic matter, disclosed some small pieces of green substance in practically all fishes, which seemed to defy all identification Considerable breaking up from original condition undoubtedly occurred, due probably to grinding up by the gritty inorganic matter, with which it was closely bound up It was in all cases in this study impossible to say what the source was, whether algæ or some other plant Varying quantities of distinguishable plant material also were present (as listed in the tables), and of these all the smaller forms (unicellular blue-green algæ and green algæ, as well as the diatoms), were entirely intact Likewise filaments of short length of both blue-green and green algæ were present Of the latter numerous, very short and much broken pieces, often only one cell pieces, were found, so that it seems that further trituration of such, by means of the gritty inorganic matter, may account for some of the unrecognizable plant remains Contents of various plant cells may also give to small masses of inorganic matter, a green tinge In fact, at first large unrecognizable masses were frequently noted, of somewhat greenish tinge under the light coming through the compound microscope, but it was soon realized that all such had to be laboriously broken up, for masses of elongate diatoms placed criss-cross fashion, together with granules and a little plant substance, made dense masses, which had to be much separated before constituents with percentages for each could be fairly recorded

Diatoms formed in practically all instances a prominent item of food In by far the most adult specimens they formed the largest item of organic material, but were overshadowed (except in a few cases) by the inorganic constituents But it was in the young specimens that diatoms formed such a preponderant part of the entire canal contents Excluding a few striking exceptions, the diatoms formed in them from half to nine-tenths of the total In fishes of one locality the diatoms are mostly of just one or a few species In fishes of groups 1 and 2, coming from three localities, the diatoms were slender elongate species of Navicula, or some species of the very slender genus Nitzschia, with a relatively few of forms like Gomphonema and Tabellaria No real identifications were attempted in this or other groups of food organisms Altogether in the food survey here made, at least a dozen kinds of diatoms were present, but never so very many species in one intestine In the fishes of Table 5, though coming from various localities, there was a preponderance of just a few forms, of which an outstanding type was a somewhat Navicula-like form, short, but bent, possibly Cymbella In some young specimens, masses of very slender, elongate diatoms were sometimes massed like clumps of needle-like crystals, held by minute quantities of other substances

Bacteria formed an appreciable percentage in quite a number of fish Examination showed that, smaller than practically any other particles, and of more regular shape, but not always positively distinguishable from the smallest regular clay or silt-like particles, were some small oval to short rod-shaped forms, that would vibrate with Brownian movement in the dilute food smears on the slides That they were bacteria there was no doubt, but what their role in the food was, or whether rather intestinal flora than an item of diet, could of course not be determined

The filamentous green algæ, found in a considerable number of specimens, but in very different proportions, presented quite a variety Spirogyra was oftenest found, but Mougeotia, Zygnema, Oedogonium, and Vaucheria were also represented in some fish

In a relatively few specimens among the hundreds of Campostoma collected, there were present large masses of filamentous algæ None of the specimens studied in detail for food here happened to contain such a large preponderance as did these few striking cases In these the filaments were very long, instead of broken up, gave a greenish-black color to the entire intestine, made it of softer consistency, and often pierced the weakened walls of the intestine when it was being examined In these few the filamentous algæ comprised nearly 100%

The animal food was present in much smaller amounts than the plant food in the specimens examined, but this is due probably merely to the smaller proportion of small animal forms inhabiting stream bottoms

In a few individuals there was a striking difference from this almost universal rule Among the 16 specimens from the run west of Worthington, (Table 1), there were five particularly which were unusual in possessing a diet very differently proportioned from the rest, in spite of the fact that they fed in the same locality as all the rest Moreover these five differed strikingly among themselves One had ingested 55% filamentous algæ, one 80% filamentous algæ, with an entire absence of diatoms, while the other three had large percentages of animal forms, offering thus a remarkable point of contrast to the others and also to all other Campostoma from any stream examined One of these contained 50% Cladocera, as well as 40% filamentous algæ, another 40% Copepoda and 20% Cladocera, and the other 95% Rotifers All of the latter were Anuraea, which in mass produced a delicate pink color, so unlike that of any other Campostoma The Cladocera present in the specimens just referred to, were mostly Chydorus sphaericus, with a smaller proportion of a species of Daphnia Of the 21 fish of group 2, there were two which were strikingly different in food ingested These had consumed almost entirely animal food, midge larvæ in both instances The reason for such distinct differences and for the individual ingestion of large proportions of some animal food, is not at all evident

CAMPOSTOMA FROM LAKES

Campostoma may occasionally be found in lakes In Illinois, Forbes and Richardson, 1908, p 99), found it present, (expressing the figures as coefficients of frequency), to the extent of 05 in lakes, as compared with 3 28 in creeks, 2 22 in small rivers, and 21 in large rivers

TABLE 6 INTESTINAL CONTENTS OF 8 LAKE CAMPOSTOMA.

Fish						Types Eaten with Percentages by Volume									
Specimen No.	Date of Collect.	Locality of Collect Lake	Length of Fish	Length of Intest	Degree Filled	Bacteria	Diatoms	1-Cell Blue-green	Filament Blue-green	1-Cell Green Algae	Desmids	Filament Green	Unrecog Plant Rem	Setae Annelida	Inorganic
45	June 28	Lake St. Mary s	33	111	1	2				15	3	15	30		35
47	Aug 14	Summit Lake	37	78	½	3	10	1	5				35	1	45
48	" 16	Milton Reservoir	36	109	⅔	2	15		18				25		40
340	Sep. 1	Buckeye Lake	36	146	1	4	20			2	2	2	20		50
558	June 30	Nettle Lake	26	95	1	1	55		5			1	10		28
561	" "	" "	30	135	1	1	45	1	3				15		35
564	" "	" "	35	130	¾	1	20	1			1	15	12		50
565	" "	" "	34	160	¾	2	35	2	10		1		10		40

In the present work a relatively very small number were secured from lakes, although fully as much seining proportionately was done in lakes as in streams, so that the scarcity of this species in lakes is demonstrated All lake specimens at hand were used, (table 6), except a few from Nettle Lake, where a fair number were obtained The specimens included in the table were thought to be sufficient In fact, in no case, even in the study of the young creek specimens (tables 1, 2, 3), were all individuals used that were collected

In lakes the species appears to be restricted to certain few parts where environment compares favorably in at least some important features, with that of streams, where Campostoma is usually found Of course it is not to be expected that lake specimens are individuals adapted to deep water, or to shoreward marshes, etc Different lakes would differ much in their likelihood of harboring Campostoma The five lakes represented are far apart and differ in many details, which are of no import here, except to show that Nettle Lake is evidently more uniformly of a sort suitable for the existence of this fish It is shallow, clear, and has a sandy bottom throughout In the case of the other lakes, the Campostoma taken were also from situations near shore where there was similarly a sandy or a somewhat pebbly bottom

Examination of table 6, and a comparison with all preceding tables, shows no striking general difference between the stream and lake Campostoma The latter are in part, of similar size as specimens of table 2, although it happens that most are of length between those of tables 2 and 3 If one considers all these more or less comparable specimens, and excludes especially the few very unusual diet individuals from the stream series, very little appreciable difference in diet is noticeable between stream and lake specimens, although one might conclude that there were slightly fewer diatoms, somewhat more algæ, and somewhat more inorganic matter in the lake specimens Granting that these differences are negligible, it is nevertheless true that there seems to be a larger variety and possibly a larger quantity of algæ In the diet of a few of the lake specimens were found Pediastrum and one or two other green algæ, absent from stream specimens These are typical lake forms, though not generally found on the bottom Their presence, but in such small percent, is then just what one might expect

This data, though meagre, really shows that there is no particular selection of food organisms, for the lake specimens consumed such food as was present The diet was similar to that of the majority of stream specimens, merely because the habitats presented in most respects the same general types of food materials This is a prerequisite In lake environments differing much from streams in the available food supply, Campostoma would not be found

The question of the larger differences between the stream fauna and flora and that of the particular lake habitats in which Campostoma was secured, does not enter here In no case has there been available, detailed, comparable collections of all the organisms of these waters in order to make comparison between existing fauna and flora and that which was ingested

SUMMARY AND CONCLUSIONS

Campostoma anomalum, a fish of wide distribution in Ohio, is primarily found in or on riffles in streams

A study of the intestinal contents of a considerable series of specimens of various sizes and from many streams, seems to allow the following conclusions

This species of fish is a bottom feeder par excellence, the ventrally directed mouth being applied in removing both loose bottom materials and attached growths Particles ingested are generally of microscopic size, except that in some instances fairly long filaments of filamentous algæ may be ingested

A large amount of inorganic material is present in the canal Often as much as three-fourths of the total is of inorganic nature in the adults In the young there is a uniformly smaller percentage

Organic material is present, forming in the adults from less than a fourth to fully a half of the contents, and in the young generally from three-fourths to nine-tenths of the total

Plants are far more abundant than animals in the diet, there being only trifling amounts of the latter, except in a few exceptional cases where certain animal organisms were taken in large quantity

Diatoms form the preponderant item of organic nature in the alimentary canal, of both young and adult, except for a few unusual cases In young fishes diatoms may form from one-half to nine-tenths of the total contents

The difference between young and adult can hardly be explained on the basis of selection of food but there is a correlation between the much lower percentage of organic material in the adult and its relatively very long intestine

The few instances of striking differences in diet of young fishes from that of the rest taken at exactly the same place and time is not explicable at present

A few lake specimens showed no notable differences in diet These specimens were from situations that resembled in some important features some general stream habitats

On the whole the diet is such as one might naturally expect in the environment which Campostoma frequents A general uniformity of diet among large numbers of specimens is not remarkable considering the uniformity of its habits and habitats

This minnow is particularly valuable as fish food because it forms in one step [like the gizzard shad in a different aquatic situation (Tiffany 1920 p 121)] the chain from the very fundamental microscopic food materials to the game fishes It ingests directly the abundant rich bottom debris living upon diatomaceous and other organic remains It serves as good food for game fishes Furthermore it is common and tenacious of life It must receive important consideration in any future more intensive fish cultural practice

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Received for publication September 5 1923

OHIO RECORDS OF THE JUMPING MOUSE

Zapus hudsonius, Zimmerman

H A GOSSARD
Ohio State Experiment Station

This species has been assumed to be present in Ohio by the earlier writers, because it was known to be found north, south, east and west of it, but definite records of its occurrence in the state seem to be very few A W Brayton in his Report on the Mammalia of Ohio, Vol IV, p 132, Geological Survey of Ohio, states "Mr Langdon has recognized it satisfactorily in Ohio, but mentions no specific locality " Mr Brayton observes that "We should naturally expect an animal (in Ohio) whose dispersion is probably not less than that of *Hesperomys leucopus*, particularly as it shows a strong preference for woodlands and as there are no very extensive treeless areas in Ohio "

I have found three definite records of its occurrence in this state The first is recorded in the Second Annual Report of the Ohio Academy of Science, p 15 Ernest W Vickers exhibited a specimen at the second annual meeting, 1894, taken in a grain field, September, 1893, at Ellsworth, Mahoning County Two more were captured and others seen later in September The second is in North American Fauna, Bull 15, p 17, Aug , 1899, where E A Preble records it from Portland Station, doubtless Portland in Meigs County, well toward the southeastern part of the state The third is in the Ohio Naturalist for June, 1906, Vol VI, p 551, where Professor J S Hine says "The jumping mouse, *Zapus hudsonius americana*, was observed to be abundant in certain parts of Summit County last summer Mr Eugene F Cranz captured a number of specimens at Ira They were found mostly in fields of standing grain and hay "

I am able to add a fourth record because in December, 1922, I received from County Agricultural Agent C O Reed, of Tiffin, Ohio, a specimen of this mouse, collected by Mr Frank Hepp of Berwick, Seneca County, Ohio Mr Hepp writes "They made their appearance in our neighborhood about 5 or 6 years ago, at least they first attracted my attention at that time They seem to live in colonies in some localities, as about New Riegel They are now quite plentiful in some other localities I have yet four mounted specimens," Dr R C Osburn also reports that specimens, said to have been collected in Scioto and Ross Counties, have been brought to him, making in all six authenticated records for the state

In the publications of the Field Museum of Natural History, Zoological Series, Vol XI, p 251, Feb , 1912, C B Cory gives a map illustrating the approximate distribution of this species and indicates that it is found over the whole of Ohio except in a few of the southern counties along the Ohio River

Ernest Thompson Seton in his Life Histories of Northern Animals or Mammals of Manitoba, gives in Vol I, p 589, a provisional map which includes only the northern one-third or one-fourth of Ohio in its range If Preble's record refers to Portland in Meigs County, the map by Cory is the more nearly correct

An inquiry addressed to Gerrit S Miller, Curator of Mammals, U S Nat Mus , has failed to uncover any additional Ohio records The only Ohio specimen in the National Museum is the one collected by E A Preble

The specimen sent me by Mr Hepp seems to be typical *hudsonius*, 8 inches long, hind foot 1 1-8 inches long, tail 4 5-8 inches in length The coloring is also typical for *hudsonius* so far as can be determined from the printed description

NATURAL HISTORY

This mouse is commonly found in thickets by meadows and along the edges of woods The prairie form is an inhabitant of the prairie border-lands, usually near low thickets of brush and weeds, near streams or ponds, among groves of the half-open country

The species is never abundant in the sense that we apply that word to other species of mice As an example of maximum abundance it is recorded that E A Preble once obtained a score of specimens in four days at Oxford House, Canada

It is a solitary species, except that a family seems to stay together near the mother until they are nearly grown In Iowa, twenty-five or thirty years ago, the writer saw 5 or 6 of a family in action almost simultaneously, much like a bunch of frogs behave when startled When quite young and until they are nearly grown, the offspring cling to the teats of the mother when she is frightened and are carried along with her in her leaps

This mouse does not jump in ordinary traveling or when searching for food, but when escaping from danger, real or supposed It may cover 10 or 12 feet at the first bound, three or four others of 8 to 10 feet follow, then it slows down to leaps of 3 or 4 feet, which are continued until it considers itself out of danger Its course of flight is often irregular, sharply angular or reversed according to necessity In these leaps the long tail acts both as a rudder to steer the course and as ballast to keep the head skyward G S Miller, Jr , in his Mammals of New York, refers to an individual that had lost its tail by the knife of a mowing machine It could leap to a tremendous distance but had no power to steer its movements Once launched into the air, its body would turn end over end, and it was likely to alight facing the direction from which it had come The next frantic leap would carry it back to its starting point

The species feeds on small seeds, such as *Amaranthus*, *Ambrosia*, burr-marigold, beggar or sheep ticks, beech nuts, berries and grain, also buds, leaves, twigs, bark, grass and almost any sort of vegetable growth It stores grain, buckwheat and nuts for winter use

It makes for the winter a warm, comfortable nest below the reach of frost, preferably under an old stump, and in this hibernates like the woodchuck and skunk It may awaken from its torpor several times during the winter if warm periods violently alternate with cold ones

While departing considerably from the burrowing type of mouse, this species is a true burrower and in summer lives in short, shallow burrows underground, in fall and winter these are made much deeper

The distribution of the type species is from Hudson Bay south to New Jersey and in the mountains to North Carolina, west to Iowa and Missouri and northwest to Alaska

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1912 *Zapus hudsonius* C B Cory Mammals of Illinois and Wisconsin Field Publication of Nat Hist 153, Zool Ser Vol XI, pp 247-252

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A REVIEW OF THE GENUS PRIONOCHILUS STRICKLAND AND ITS CLOSEST ALLIES

HARRY C OBERHOLSER

The genus *Prionochilus* of the Catalogue of Birds in the British Museum[*] included several well differentiated generic groups These have been partly segregated by subsequent authors notably Oates[†] Buttikofer[‡] and Hartert[§] and the present paper is a further contribution to the same subject

The old genus *Prionochilus* is now divisible into eight which fall naturally into two main groups one comprising three genera with a spurious primary and another comprising five genera in which there is no evident spurious primary and in which the wing is thus apparently nine primaried like most of the Dicaeidae In fact so different are these two groups that there is some doubt of the propriety of retaining the first mentioned in the family Dicaeidae

In the present paper the comparative measurements used have been taken as follows

Length of wing—Measured in a straight line from the bend of the closed wing to the end of the longest primary with the primaries in their natural position—that is not straightened

Exposed culmen (*length of bill*)—Measured in a straight line from the beginning of the feathers on the culmen to the tip of the maxilla—that is the chord of the exposed culmen

Width of bill at base—Taken with dividers at the beginning of the feathers on the culmen

Length of tarsus—A straight line from the center of the heel joint on the posterior side to the middle of the joint between the metatarsus and the middle toe on the anterior side

The conclusions hereinafter set forth are based chiefly on material in the United States National Museum In addition the writer is indebted to the authorities of the Academy of Natural Sciences at Philadelphia Pennsylvania through Dr Witmer Stone and those of the Museum of Comparative

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[*] Sharpe Cat Birds Brit Mus X 1885 pp 63 70

[†] Fauna Brit India Birds II 1890 after October pp 375 381 386

[‡] Weber s Zool Ergeb Reis Nederl Ost Ind en 1894 pp 302 303

[§] Nov t Zool IV No 3 December 3 1897 p 519

Zoology, Cambridge, Massachusetts, through Mr Outram Bangs, and to Mr J H Fleming, of Toronto, Ontario, for the loan of additional specimens

Pachyglossa Blyth

Pachyglossa BLYTH (Hodgson MS), Journ. Asiat Soc Bengal, XII, Part II, No 143, for November (after November 13), 1843, p 1009 (type, by virtual monotypy,* *Pachyglossa melanoxantha* Blyth, Hodgson MS, sp nov)

Description —First (outermost) primary spurious, not as long as the tarsus (not longer than hind toe with claw), third primary longest, second primary much longer than the seventh, secondaries falling short of the tip of the wing by more than the length of the tarsus, wing very long, nine and one-half times the length of exposed culmen, tail square or slightly emarginate, bill moderately stout and relatively broad, its lateral outlines concave, its width at base nine-tenths of the length of exposed culmen, culmen strongly decurved, gonys moderately ascending and moderately convex, narial bristles few and poorly developed

Type —*Pachyglossa melanoxantha* Blyth

Remarks —The only species is *Pachyglossa melanoxantha* Blyth

Anaimos Reichenbach

Anaimos REICHENBACH, Handb Speciell Ornith, Nov 1, 1853, p 245, (type, by monotypy, *Pardalotus thoracicus* Temminck)

Diagnosis —Similar to *Pachyglossa*, but first (outermost) primary at least as long as the tarsus, third, fourth, and fifth primaries longest, secondaries falling short of tip of wing by less than the length of the tarsus, wing less than 8 times the length of the exposed culmen, lateral outlines of bill practically straight, width of bill at base about ¾ of the length of the exposed culmen, gonys strongly ascending and much convex, narial bristles numerous and well developed

Description —First (outermost) primary spurious, but as long as the tarsus, third, fourth and fifth primaries longest, second primary much

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*The expression "virtual monotypy," which has been previously used by the present writer, is intended to indicate that while in the original description of a genus there may have been more than one specific name mentioned, yet only one is to be considered in fixing the type Such specific names include (1) nomina nuda, (2) absolute synonyms that could not by any possible chance be used for another species or subspecies, (3) species inquirendae from the standpoint of the author of the generic name, and (4) species doubtfully referred to the genus by its original describer In the case of *Pachyglossa*, as above indicated, the following three other species were doubtfully referred to this group by Blyth *Pipra squalida* Burton, *Piprisoma vireoides* Jerdon, and *Pardalotus pipra* Lesson longer than the seventh, secondaries falling short of the tip of the wing by less than the length of the tarsus, wing long, 7 to 7½ times the length of the exposed culmen, tail square, or very slightly rounded, bill moderately stout and relatively broad, its lateral outlines practically straight, its width at base about ¾ of the length of exposed culmen, culmen strongly decurved, gonys strongly ascending and convex, narial bristles numerous and well developed

Type—*Pardalotus thoracicus* Temminck

Remarks—This group is well differentiated from *Pachyglossa,* as may be inferred from the above diagnosis The species are

Anaimos thoracicus (Temminck)
Anaimos olivaceus (Tweeddale)

*Charitociris,** nom gen nov

Prionochilus STRICLLAND, Proc Zool Soc Lond , 1841, (October, 1841), p 29, (type, by subsequent designation [Gray, List Gen Birds, ed 2, August, 1841, p 46], *Pardalotus percussus* Temminck), (nec *Prionocheilus* Chevrolat, *Coleoptera*)

Diagnosis—Similar to *Anaimos,* but wing about 6 times the length of exposed culmen, second primary equal to the seventh, or shorter, bill relatively narrow and slender, not turgid, its width at base about three-fifths of the length of exposed culmen, culmen not much decurved, the gonys not strongly convex, nor strongly ascending

Description—First (outermost) primary spurious, but as long as the tarsus, third, fourth, and fifth primaries longest, second primary equal to the seventh, or shorter, secondaries falling short of the tip of the wing by less than the length of the tarsus, wing 6 times the length of the exposed culmen, tail square, or very slightly rounded, bill relatively slender and narrow, its lateral outlines practically straight, or but slightly concave, its width at base about three-fifths of the length of exposed culmen, culmen not strongly decurved, gonys moderately ascending and convex, narial bristles numerous and well developed

Type—*Pardalotus percussus* Temminck

Remarks—This genus differs from *Pachyglossa* in having numerous and well developed narial bristles, long secondaries, falling short of the tip of the wing by less than the length of the tarsus, the first primary at least as long as the tarsus, the second primary equal to or falling short of the seventh, the wing only 6 times the length of the exposed culmen, and in some other particulars

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**Charis,* gratia, *kiris,* ciris (avis mythica)

The generic name *Prionochilus* Strickland* is rendered invalid by *Prionocheilus* Chevrolat† for a genus of *Coleoptera*, as already explained by the present writer,‡ but the name *Anaimos* Reichenbach, that we used for this genus in its original sense, is not now applicable to the present group It is further worth while mentioning that the type of *Prionochilus* Strickland usually cited is *Dicaeum ignicapillum* Eyton, but this species is not mentioned in the original diagnosis, and the proper type was therefore apparently first designated by Gray§ as *Pardalotus percussus* Temminck The species referable to this group are as follows

Charitociris percussa percussa (Temminck)
Charitociris percussa ignicapilla (Eyton)
Charitociris xanthopygia xanthopygia (Salvadori)
Charitociris xanthopygia plateni (Blasius)
(=*Prionochilus johannae* Sharpe)
Charitociris maculata maculata (Temminck)
Charitociris maculata septentrionalis (Robinson and Kloss)
Charitociris maculata opistata (Oberholser)

Piprisoma Blyth

Piprisoma BLYTH, Journ Asiat Soc Bengal, XIII, pt I, No 149, for May (after October), 1844, p 394, (type, by monotypy, *Fringilla agilis* Tickell = *Pipra squalida* Burton)

Diagnosis—Similar to *Charitociris*, but first (outermost) primary not spurious, and much longer than the fourth, second and third primaries longest, secondaries falling short of the tip of the wing by more than the length of the tarsus, and the wing more than 7 times the length of exposed culmen

Description—First (outermost) primary not spurious, much longer than the fourth, second and third primaries longest, secondaries short, falling short of the tip of the wing by more than the length of the tarsus, wing long, 7½ to 8 times the length of exposed culmen, tail slightly rounded, bill rather slender and narrow, but broadening at base, its lateral outlines more or less concave, its width at base three-fifths to two-thirds of the length of exposed culmen, culmen not strongly decurved, gonys only moderately ascending and little convex, narial bristles few and rather weak

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*Proc Zool Soc Lond, 1841 (October, 1841), p 29
†In Dejean, Cat Col, ed 3, 1837, p 451
‡Smithson Miscell Col, LX, No 7, October 26, 1912, p 22
§List Gen Birds, ed 2, August, 1841, p 46

Type.—Pipra squalida Burton

Remarks—The three preceding genera all have a spurious first primary, so that *Piprisoma* is distinguishable from them at a glance.

The generic term *Piprisoma* is not of neuter gender as commonly considered, since, being a compound appellative, it must be either masculine or feminine In view of the feminine form of its ending, it is probably better considered to be of that gender

The species referable to this genus are

Piprisoma modesta modesta (Hume)
Piprisoma modesta remota Robinson and Kloss
Piprisoma everetti everetti (Sharpe)
Piprisoma everetti sordida Robinson and Kloss
Piprisoma squalida (Burton)

*Cryptociris,** gen nov

Diagnosis—Resembling *Piprisoma*, but with secondaries long, falling short of the tip of the wing by less than the length of the tarsus, width of bill at base more than three-fifths of the length of exposed culmen, tail strongly rounded

Description—First (outermost) primary not spurious, much longer than the fourth, first, second, and third primaries longest, secondaries long, falling short of the tip of the wing by less than the length of the tarsus, wing long, about 7¾ times the length of the exposed culmen, tail strongly rounded, bill rather slender and relatively narrow, but broadening at base, its lateral outlines more or less concave, its width at base about ¾ of the length of the exposed culmen, culmen not strongly decurved, but relatively more so than in *Piprisoma*, gonys only moderately ascending and moderately convex, narial bristles few and weak.

Type—Pardalotus obsoletus Müller and Schlegel

Remarks—This monotypic group is most nearly allied to *Piprisoma*, but is readily distinguishable as above indicated Its only species is *Cryptociris obsoleta* (Müller and Schlegel)

Chromatociris† gen nov

Diagnosis—Similar to *Cryptociris*, but with the second, third, and fourth primaries longest, the first (outermost) primary shorter than the fourth, wing not decidedly more than 7 times the length of the exposed culmen, tail only slightly rounded, bill stouter, culmen strongly decurved; narial bristles more numerous and better developed

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* *kryptos*, color, *kiris*, ciris (avis mythica)
† *Chroma*, occultus, *kiris*, ciris (avis mythica).

Description —First (outermost) primary not spurious, but shorter than the fourth and equal to the fifth or longer, second, third, and fourth primaries longest, secondaries long, falling short of the tip of the wing by less than the length of the tarsus, wing six and two-thirds to seven times the length of the exposed culmen, tail slightly rounded, bill moderately stout and basally wide, its lateral outlines more or less concave, its width at base three-fourths to five-sixths of the length of exposed culmen, culmen strongly decurved, gonys moderately or slightly ascending and straight or slightly convex, narial bristles numerous and well developed

Type —*Prionochilus quadricolor* Tweeddale

Remarks —The narial bristles appear to be rather weaker in *Chromatocirıs bicolor inexpectata* than in the type of the genus, *Chromatocirıs quadricolor*, but otherwise the former is typical The species referable to this group are

Chromatocirıs bicolor bicolor (Bourns and Worcester)
Chromatocirıs bicolor inexpectata (Hartert)
Chromatocirıs quadricolor (Tweeddale)

Acmonorhynchus Oates

Acmonorhynchus OATES, Fauna Brit India, Birds, II, 1890, after October, p 381 (type, by monotypy, *Prionochilus vincens* Sclater)

Diagnosis —Similar to *Chromatocirıs*, but with bill narrower and more slender, its lateral outlines practically straight, its width at base only two-thirds of the length of exposed culmen, culmen not strongly decurved, second and third primaries longest

Description —First (outermost) primary not spurious, shorter than the fourth sometimes only as long as the fifth, second and third primaries longest, secondaries long falling short of the tip of the wing by less than the length of the tarsus, wing only six and two-fifths times the length of exposed culmen, tail moderately rounded, bill slender and relatively narrow, its lateral outlines practically straight, its width at base about two-thirds of the length of exposed culmen, culmen not strongly decurved, gonys moderately (not abruptly) ascending, and but little convex, narial bristles many and well developed

Type —*Prionochilus vincens* Sclater

Remarks —The Ceylon species *Prionochilus vincens* Sclater, for which this genus was originally instituted, seems to be strictly congeneric with *Prionochilus aureolimbatus* Wallace Although we have not examined *Acmonorhynchus annae* Büttikofer*, this species is likewise apparently correctly referred to the present group The species apparently belonging to this genus are

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*Weber's Zool Ergeb Reis Nederl Ost-Indien, 1894, p 302

Acmonorhynchus vincens (Sclater)
Acmonorhynchus aureolimbatus aureolimbatus (Wallace)
Acmonorhynchus aureolimbatus sanghirensis (Salvadori)
Acmonorhynchus annae Büttikofer

Chilociris[*] gen nov

Diagnosis —Resembling *Acmonorhynchus*, but wing more than 7½ times the length of the exposed culmen, secondaries falling short of the tip of the wing by the length of the tarsus or more, third and fourth primaries longest, bill stouter, its lateral outlines more concave, the culmen strongly decurved, the gonys much convex and abruptly ascending

Description —First (outermost) primary not spurious, equal to the fourth or shorter, third and fourth primaries longest, secondaries shorter, falling short of the tip of the wing by the length of the tarsus or more, wing long, 8 to 8½ times the length of the exposed culmen, tail square, or very slightly rounded, bill turgid, widening at base, its lateral outlines more or less concave, its width at base two-thirds to seven-tenths of the length of the exposed culmen, culmen strongly decurved, gonys abruptly ascending and very convex, narial bristles numerous and well developed

Type —*Prionochilus aeruginosus* Bourns and Worcester

Remarks —The type and only specimen of *Chilociris* has apparently given ornithologists considerable trouble to allocate generically Originally described as belonging to *Prionochilus*, it has successively been placed in *Acmonorhynchus* and *Piprisoma*, but as is shown by an examination of its characters, it can not properly be referred to any one of them It really forms a well differentiated monotypic genus, and should stand as *Chilociris aeruginosa* (Bourns and Worcester)

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[*] *Cheilos*, rostrum, *kiris*, ciris (avis mythica)

Key to Genera Allied to Prionochilus

a^1 First (outermost) primary spurious

  b^1 Narial bristles few and weak secondaries short falling short of the tip of the wing by more than the length of tarsus first primary not as long as tarsus *Pachyglossa*

  b^2 Narial bristles numerous and well developed secondaries long falling short of the tip of the wing by less than length of tarsus first primary at least as long as tarsus

    c^1 Wing 7 to 7⅓ times the length of exposed culmen second primary much longer than seventh bill relatively broad and stout decidedly turgid its width at base at least seven tenths of the length of exposed culmen culmen much decurved the gonys strongly convex and strongly ascending *Anaimos*

    c^2 Wing about 6 times the length of exposed culmen second primary equal to the seventh or shorter bill relatively narrow and slender not turgid its width at base about three fifths of the length of exposed culmen culmen not much decurved gonys not strongly convex nor strongly ascending *Charitociris*

a^2 First (outermost) primary not spurious

  b^1 First primary much longer than fourth narial bristles few and weak

    c^1 Secondaries short falling short of the tip of the wing by more than the length of tarsus width of bill at base not more than three fifths of the length of exposed culmen tail only slightly rounded *Piprisoma*

    c^2 Secondaries long falling short of the tip of the wing by less than the length of tarsus width of bill at base more than three fifths of the length of exposed culmen tail strongly rounded *Cryptocirus*

  b^2 First primary not longer than fourth narial bristles numerous and well developed

    c^1 Wing not decidedly less than 8 times the length of the exposed culmen secondaries falling short of the tip of the wing by the length of the tarsus or more bill somewhat more turgid gonys much convex and abruptly ascending *Chilocirus*

    c^2 Wing decidedly less than 8 times the length of exposed culmen secondaries falling short of the tip of the wing by less than the length of the tarsus, bill less turgid gonys but little if any convex and not abruptly ascending

      d^1 Bill slender and narrow its lateral outlines practically straight its width at base two-thirds of the length of exposed culmen culmen not strongly decurved, second and third primaries longest *Acmonorhynchus*

      d^2 Bill relatively stout and basally wide its lateral outlines more or less concave its width at base three fourths to five sixths of the length of exposed culmen culmen strongly decurved second, third and fourth primaries longest *Chromatociris*

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NOTES ON THE FAMILY SYRPHIDÆ (DIPTERA) WITH THE DESCRIPTION OF A NEW SPECIES

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The following notes have been taken from material collected at different times during the past three years It is hoped that they may be of interest to other workers

Myiolepta pretiosa, new species

Female —Head shining black, ground color obscured by thick whitish pollinose areas to the following extent a triangular patch on each side of the front, just above the antennæ, with bases upon the orbits, a pollinose band from eye to eye, below the antennæ, the ends descending along the eyes and extending transversely, in their full width, between the cheek and face region to the edge of the mouth This last portion of the pollinose area is twice as wide in extent as in *M varipes* Loew Thus the tubercular area of the face is left shining black Profile of the face nearly as in *M varipes* Antennæ somewhat darker than in that species, third joint ochraceous brown, first and second joints slightly darker, arista similarly colored, blackened apically Pollen of occiput grayish white, pile long, white Ocelli white or yellowish

Dorsum of thorax and scutellum shining black, with a slight metallic brassy cast. Pile short, appressed, white (pile in *varipes* brassy yellowish) Pleuræ shining black (vitreous), pile white, longer and more erect On the extreme anterior portion of the dorsum of the thorax is found a band, or pollinose region, which (though in some species it may be reduced to spots), is characteristic for all species of *Myiolepta* with which I am acquainted (we might look upon the pollinose bands of *Brachyopa* as an extension of these) In *M varipes* female, this band is cut off sharply in a line from humerus to humerus, while in the present species these bands proceed posteriorly for nearly a third of the length of the thorax, they are best seen from a slanting angle

Abdomen entirely shining black, with a slight bluish or brassy tinge, a faint indication of whitish at the junction of the first and second segments on the lateral margins A slightly opaque spot on the median anterior half of the second segment Pile of the abdomen white, semi-recumbent, longer on the fourth segment, longest and erect on the lateral margins of the second segment Venter pale on first and a portion of second segments, remainder dark Halteres dirty light yellowish

Legs. Anterior side of front coxæ opaque (shining black, nearly bare, in *M varipes*) and densely gray pollinose Trochanters and

femora shining fulvous, the latter becoming black on the distal half, tips of femora fulvous Tibiæ brownish yellow darker distally, whole front tarsi black (darker than in *varipes*), last three joints of middle and hind tarsi (last two joints in *varipes*) black, remainder clear, light yellow Pile of legs, including tibiæ and tarsi, white Wings as in *M varipes*
Length, 7 to 8 mm

Type and one paraytpe, both females, taken by the author from flowers of *Spiræa van-houtei* on April 7, 1922, and May 6, 1920, at Mississippi A and M College Types in the collection of the author

Myiolepta varipes Loew

Specimens studied in comparison with the above were quite constant They vary a little in size In the males the yellow color extends narrowly on to the third segment, and occupied in the females nearly all of the second Five specimens from the Mississippi A and M College, May 6, 12, 1920 and 1921, March 19, 1921, March 6, and April 7, 1922 Taken at flowers of *Spiræa van-houtei* Additional specimens, Hinckley, Ohio, August 1, 1901, (J S Hine), Clemson College, South Carolina, 1920 (M R Smith)

Myiolepta nigra Loew

One specimen Mississippi A and M College, May 12, 1920

Myiolepta strigilata Loew

Taken with the preceding species from *Spiræa van-houtei* Mississippi A and M College May 6, 1920, March 19, April 4, 1921, March 24, 1922 Also from College Station Texas April 12, 1915 (H J Reinhard)

Microdon scitulus Williston

Found in abundance, on the edge of a cypres swamp, flying over and resting on the leaves of plants close to the ground at Greenville, Mississippi, Sept 18, 1920, and Sept 11, 1922 Also taken at Mississippi A and M College, May 13, 1921, and Memphis, Tennessee, Sept 7, 1920 Professor Jas S Hine refers to this species as *M coarctatus* Loew, Ohio Naturalist, XIV, 334

Microdon baliopterus Loew

One specimen from Kingsville, Texas, July 6, 1921, and several specimens on foliage at Harlingen, Texas, July 18, 1921, (F M Hull) Two were taken at Brownwood, Texas, June 24, 1921, (R H Painter)

Microdon pallipennis Snow

Not recorded since first described Two specimens were collected by Mr R H Painter, at Austin, Texas, April 10, 1921

Volucella obesa Fabr

I have a male and a female of this species taken at Riverton, New Jersey, July 3, 1920, resting on foliage, by Mr R H Painter A third was observed on leaves of *Clethra alnifolia*, but not upon the flowers The female is peculiar in that the whole thorax and abdomen as well as the front and face, are a deep metallic reddish bronze color Practically the only greenish tinge upon it is in the eyes Otherwise it appears to be the same in detail as typical *obesa* The male is deep metallic green and shows no variation save that the second abdominal segment has two large moderately shining black spots, separated by a narrow median line of metallic green This record marks a considerable extension of the range of the species

Volucella pallens Wied

One specimen, Austin, Texas, Sept 30, 1922 (R H Painter)

Volucella fraudulenta Williston

About seven specimens of this species were taken hovering a foot or so above the ground, and making a faint humming sound, at Harlingen, Texas, June 22, and July 24, 1921 They were on the edge of an open field and were observed only about 8 o'clock in the morning and by 9 o'clock they had disappeared They are somewhat larger (length 10 to 12 mm) than the typical specimens of Williston, but agree in having the light markings of the abdomen as well as the face tinged with yellowish Three specimens from San Angelo, Texas, Sept 13, 1921, (R H Painter), differ in lacking this color and having at least the first two abdominal bands nearly clear hyaline They are eight to ten millimeters in length

Baccha lineata Macq.

Baccha lineata Macq., *Dipt. Exot., Suppl.* 1, 130
Baccha livida Schiner, *Novara*, 343
Baccha tropicalis Town., *Jour. N. Y. Ent. Soc.*, v. 172
(?) *Baccha flavipennis* Wied., *Auss. Zweifl.*, ii, 123

Five or six specimens of this beautiful species were taken at Harlingen, Texas, about shrubs and flowers. I believe the above synonymy is correct. Harlingen is fifteen miles from Brownsville, (the type locality of Townsend's species) and my specimens agree in detail with his description, with the exception that he does not mention, in the male, a second pair of brownish lines, enclosing the median longitudinal pair, together with brownish lateral margins, on the third, fourth and fifth abdominal segments. He does describe such lines for the female. However, both the thorax and abdomen are very apt to become peculiarly discolored with brown or black and the linear marking obliterated. When fresh the abdominal coloring is, save for the brown markings, clear amber yellow. Professor Jas. S. Hine, Ohio Naturalist, xiv, 336, has already remarked on the relationship of *lineata* Macq. to *livida* Schiner. A comparison of the above mentioned specimens with his material from Guatemala, Honduras, and British Guiana, only confirms this.

Townsend does not mention a light brownish, subapical band on the hind femora. Some, not all, of the specimens have such a band in addition to the similarly infuscated area on the posterior tibiæ. The occiput likewise varies from yellow to gray pollinose. The infuscation of the wings seems to be slightly variable, with, in the female, a greater extent of hyaline portion in the apical half of the wing. Nearly the whole insect has a peculiar glassy, or vitreous appearance, as if it had been varnished.

I am led further by a study of the descriptions, and the notes by Williston, Trans. Amer. Ent. Soc., xv, 267–268, in connection with the present material, to doubt the distinction of *Baccha flavipennis* Wied. The lack of Brazilian material forbids a more definite statement.

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